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Research Report 1693

Characterization of Sleep, Mood, and Performance Patterns in Battalion Staff Members at the Joint Readiness Training Center

Robert J. Pleban and Tina L. Mason
U.S. Army Research Institute

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EDGAR M. JOHNSON
Director

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David M. Penetar
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14. ABSTRACT *(Maximum 200 words)*:

This research tracked the sleep/work patterns of 10 members of a battalion staff during a low-intensity conflict scenario. Sleep patterns were captured by wrist-worn activity monitors that permitted minute-by-minute assessment of the activity levels of each staff member. Staff members were monitored over a 16-day rotation. Data on sleep habits and perceptions of work load levels were collected using paper-and-pencil questionnaires. Daily estimates of cognitive work capacity were obtained using a computerized synthetic work task. In addition, a brief computerized sleepiness-mood scale was presented each day. Staff members slept, on the average, 5.2 hours (range 3.5-6.4 hours) per day. The staff averaged almost 3 hours less sleep per day on rotation than what they indicated they needed for total recovery (8.1 hours sleep per day). Certain staff positions (XO, S2, and S3-Plans) received very little sleep across the rotation (3.7-4.6 hours sleep per day). Over 60 percent of the sleep obtained was fragmented in nature (sleep periods of 10 minutes or less). Substantial increases in response variability were noted for one staff member. This preliminary research, together with observations from the combat training centers, suggests that to effectively sustain staff performance during continuous operations, better utilization of staff resources is critical. In addition, commanders must take an active role in the development of unit sleep/work management plans. This includes educating unit members on the importance of sleep in combat operations and how to optimize the recuperative value of available sleep periods through specifically tailored unit sleep plans.

15. SUBJECT TERMS

Continuous operations   Cognitive work load   Battalion staff work load
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Research Report 1693

Characterization of Sleep, Mood, and Performance Patterns in Battalion Staff Members at the Joint Readiness Training Center

Robert J. Pleban and Tina L. Mason
U.S. Army Research Institute

Infantry Forces Research Unit
Scott E. Graham, Chief

U.S. Army Research Institute for the Behavioral and Social Sciences
5001 Eisenhower Avenue, Alexandria, Virginia 22333-5600

Office, Deputy Chief of Staff for Personnel
Department of the Army

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Training Systems and Education

FOREWORD

As Army doctrine calls increasingly for 24-hour, continuous operations with a particular emphasis on night fighting capabilities, opportunities for sleep continue to erode. Advances in target acquisition, communications, and sensor systems allow soldiers to fight longer, harder, and faster than ever before. Despite these recent technological advances, the soldier remains the key to future operational success. It is critical, therefore, to determine how the soldier copes with the demands placed on him in these environments.

The digitization of the modern battlefield will greatly increase the volume of information that must be processed by the soldier. Decision time will, in all likelihood, be substantially compressed. How long can the soldier effectively process information and make sound decisions? Soldiers, unlike machines, cannot operate around the clock without letup. They need time to recuperate. With limited combat personnel available for future contingency operations, it is especially critical that effective sleep/work plans be developed to enable the individual and the unit to sustain performance at acceptable levels for as long as possible.

To address this issue, sleep, mood, and work performance patterns of 10 members of a battalion staff were tracked during a low-intensity conflict scenario. This research was based, in part, on earlier findings from the Army Research Institute Infantry Forces Research Unit's (IFRU) work in the areas of battalion staff training and synchronization. This report summarizes IFRU's work on sleep/work load issues during the past 2 years.

Preliminary results from this research area were briefed to the Deputy Commander, Operations Group, Joint Readiness Training Center (JRTC), in May 1994. Final results from this research were briefed to the Commander, JRTC, in December 1995.

ZITA M. SIMUTIS
Deputy Director
(Science and Technology)

EDGAR M. JOHNSON
Director

CHARACTERIZATION OF SLEEP, MOOD, AND PERFORMANCE PATTERNS IN BATTALION STAFF MEMBERS AT THE JOINT READINESS TRAINING CENTER

EXECUTIVE SUMMARY

Research Requirements:

New technologies combined with the adoption of a force projection doctrine have greatly increased the tempo of modern warfare. These technological advances enable units to fight longer, harder, and faster than ever before.

Soldiers, however, can only work or fight so long, and then must be given some time to recuperate. With limited combat personnel available for future contingency operations, it is especially critical that effective sleep/work plans be developed and strictly adhered to by unit members.

Procedure:

This research tracked the sleep/work patterns of 10 members of a battalion staff during a low-intensity conflict scenario. Sleep patterns were captured by wrist-worn activity monitors that permitted minute-by-minute assessment of the activity levels of each staff member. Selected staff members were monitored over a 16-day rotation.

Data on staff sleep habits and perceptions of work load levels were collected using paper-and-pencil questionnaires. Daily estimates of cognitive work capacity were obtained using a computerized synthetic work task. In addition, a brief computerized sleepiness-mood scale was presented each day.

Findings:

The average daily sleep obtained by the staff members was 5.2 hours (range 3.5-6.4 hours). They averaged almost 3 hours less sleep per day than was needed for total recovery. Certain staff positions received very little sleep across the exercise. Over 60 percent of the sleep obtained was fragmented in nature (sleep periods of 10 minutes or less). Substantial increases in response variability were noted for one staff member, which is indicative of how performance degrades in continuous operations environments.

Utilization of Findings:

This research suggests that to effectively sustain staff performance during continuous operations, commanders must take an active role in the development and implementation of unit sleep/work management plans. By optimizing the recuperative value of available sleep periods, an effective sleep management plan can provide commanders with a powerful force multiplier.

CHARACTERIZATION OF SLEEP, MOOD, AND PERFORMANCE PATTERNS IN BATTALION STAFF MEMBERS AT THE JOINT READINESS TRAINING CENTER

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Introduction

The battlefields of the future are likely to be chaotic, intense, and extremely lethal. New technologies combined with the adoption of a force projection doctrine have greatly increased the tempo of modern warfare. Advances in target acquisition, communications, sensor systems, and the almost complete mechanization of land combat forces enable units to fight longer, harder, and faster than ever before [Chaisson, 1994; FM 22-9, Soldier Performance in Continuous Operations (September 1991)].

Continuous operations, the type of high intensity, fast paced, extended operations described above, will put tremendous stress on the soldier's recuperative abilities. Opportunities for sleep, while possible, may be brief or fragmented in such situations. By altering the duration, continuity, or timing of sleep, a host of 24 hour (circadian) rhythms are disrupted, which can lead to decreased waking alertness and impaired performance (Bonnet, 1985). Individuals at most risk during continuous operations are those with heavy cognitive work load requirements. Soldiers who must process and evaluate large amounts of information such as fire direction center crews (FDC), radar operators, tactical operations center (TOC) members, and leaders at all levels are most susceptible to the effects of continuous operations. Effective cognitive performance is critical for conducting the appropriate command, control, communication, and intelligence activities required for successful combat operations at all levels, from crew, squad, and platoon through division and corps (Belenky et al., 1994).

Studies have found that the upper limit for working intensively and continuously without the stress of actual combat is 2-3 days (Banderet, Stokes, Francesconi, Kowal, & Naitoh, 1981; Haslam et al., 1977). By simulating certain stressors normally found under combat conditions (e.g., heightened work load) significant decrements in cognitive performance and measurable fatigue effects have been reported after less than 24 hours of sustained work (Angus & Heslegrave, 1985; Mullaney, Kripke, Fleck, and Johnson, 1983). Mental functions degrade much faster than motor skills. Increasing sleep loss can also lead to deterioration in mood such as increased irritability, negativity, sleepiness and decreased motivation (FM 22-9; Chaisson, 1994).

Poor decision making is often noted after the first 24 hours of sleep deprivation. Difficulties in processing information increase over time. Individuals require increasingly longer time to understand oral, written, or coded information. In terms of operational effectiveness, this translates to difficulties with spot, status, or damage reports and problems in assessing even simple tactical situations. In addition, response time becomes more uneven, attention span narrows and frequent lapses in responsiveness are noticeable (FM 22-9). In an operational setting, if thinking becomes so slow or uneven that a correct decision cannot be made within a specified time period, catastrophic system failure may occur, e.g., friendly fire

casualties (Belenky, 1995). This is particularly true if the individual holds a key position in a complex system, e.g., FDC team or tank/Bradley crew member. As Belenky (1995) notes, sleep loss can cause soldiers to lose battlefield awareness and the ability to integrate information into a coherent and accurate representation of the tactical situation.

Sustaining PerformanceThrough Sleep Management

To sustain high levels of productivity in continuous operation environments, the unit must maintain an efficient balance of sleep and work (Hursh & McNally, 1993). Unit sleep management plans play a critical role in extending performance effectiveness. An effective sleep plan will provide regular opportunities for the soldier to sleep. The only remedy for sleep loss is sleep; rest is not the same as sleep. Recent research (Chaisson, 1994; Belenky, 1995) suggests that six to eight hours of continuous sleep will sustain performance indefinitely. Four to five hours of sleep will maintain acceptable levels of performance for five to six days (Chaisson, 1994). Heavy operational demands, however, may greatly reduce the quality of these truncated sleep periods (by fragmenting sleep and severely disrupting circadian rhythms), which will lessen the sleep period's recuperative value.

Sustained periods of partial sleep loss, e.g., four to five hours sleep per day, over several weeks, can lead to performance degradation from the cumulative impact of partial sleep loss. Obtaining even one hour less sleep than required can affect waking levels of sleepiness (Carskadon & Dement, cited in Rosekind et al., 1994). Unless soldiers are given enough time to adequately recover (see Chaisson, 1994), performance could suffer significantly as a result of increased operational demands, cumulative sleep debt, and circadian disruption.

Effectiveness of Sleep Management Plans: An Empirical Examination

Observer/Controllers. Work load issues are critical not only in combat but in training as well. Future reductions in training cadre, specifically, the observer/controllers (O/Cs) at the combat training centers has generated questions concerning the potential impact of increased O/C work load on O/C job performance. Preliminary observations (Pleban, Valentine, & Thompson, 1994) made at the Joint Readiness Training Center (JRTC) with battalion level O/Cs showed that they averaged anywhere from 4.7 to 6.3 hours of sleep per day across a three phase 21 day rotation. Although cognitive performance, measured by a computerized synthetic work task, did not degrade over time, there were clear subjective effects of sleep loss. More specifically, O/Cs felt significantly more irritable, less energetic, and less focused during the last phase(s) of the rotation, when compared to earlier phases. Sleepiness increased significantly during most of the rotation. The rotation-based sleep schedule was not effective in preventing decrements in the subjective quality of sleep. O/Cs felt that their present rest intervals (between rotations) did not provide sufficient time to recover from the effects of mental fatigue. Fifty percent of the O/Cs felt that their present work load was excessive. While current O/C sleep-work cycles appeared to be effective on a short term basis in sustaining performance, the subjective data clearly showed the negative impact of partial sleep

loss. When repeated over several rotations, increased sleepiness and loss of concentration will eventually lead to performance lapses that were discussed by Belenky (1995).

Battalion staff members. The digitization of the modern battlefield will greatly increase the volume of information that must be processed by TOC personnel. At the same time, decision time will decrease. With the tempo of operations greatly accelerated, the use of effective sleep/work management plans in the TOC is critical if staff/TOC personnel are to be able to function effectively for extended periods of time.

With regard to work plans, the battalion TOC must have a simple and effective system in place to receive and process information. Observation of units at the combat training centers (Center for Army Lessons Learned - CALL 95-7) indicate that TOCs with established procedures for processing messages and other types of information are more effective than those who do not (CALL 95-7). Moreover, it was found that during fast-paced operations, TOCs which lacked a standard set of procedures for ensuring uniformity and efficiency in managing information traffic were quickly overwhelmed with information during the peak of the battle and TOC effectiveness was noticeably impaired.

In addition to having a sound sleep/work plan, successful TOC operations also require that the battalion staff and support personnel be clear about each others' roles and duties and their importance for mission success. Earlier research by Thompson, Thompson, Pleban, and Valentine (1991) found, for example, that units often did not recognize the importance of certain staff sections in planning, preparing, and executing operational missions (e.g., S1). They also found that some staff members were not adequately prepared to carry out their duties. O/C observations (CALL 95-7) have also noted trends for both over and under utilizing certain staff/TOC personnel. The inefficient use of staff/TOC members can adversely affect the functioning of the TOC as key staff members such as the XO or battle captain spend unnecessary time talking on the radio, posting maps, and logging entries in journals, while other TOC members stand idly by observing. This interferes with the accomplishment of their primary jobs of integrating resources and synchronizing the fight and cuts into their sleep periods. The utilization of key staff members in this way quickly results in fatigue and frequently leads to ineffective job performance (CALL 95-7).

Objective

Land battles are won or lost by the maneuver battalion (CAS^3, 1990). The battalion staff plays an integral role in determining the ultimate success of the battalion by how well they are able to synchronize the battle plan through the coordination of movements, fires, and supporting activities. However, little, if any, empirical research exists which has examined the adequacy of current battalion staff sleep/work management plans, or organization on work performance.

The current research was concerned with the assessment of sleep-work schedules of battalion staff members at JRTC. Specific focus was directed toward staff members' sleep

habits, both during and off-rotation; identification of performance and mood changes during the course of the rotation; and evaluation of the effectiveness of current staff members' sleep schedules in sustaining performance for extended periods of time.

Method

Participants

Ten OPFOR battalion staff members from JRTC participated in this research. The average age of the staff members was 28.9 years. Age ranged from 25 to 36 years. All subjects were officers. Staff positions represented included the following: XO, S1, S2, S3, S3-Air, S3-Plans, S3-Training, S4, FSO, and ADO.

Materials

Questionnaires. Two paper-and-pencil questionnaires were developed, an OPFOR Sleep History Questionnaire (see Appendix C) and an OPFOR Work Load Questionnaire (see Appendix D). The Sleep History Questionnaire consisted of 21 multiple choice and short answer items. Questions were designed to elicit information on off-rotation sleep habits such as the timing and duration of sleep, restfulness of sleep, sleep problems, on-rotation sleep habits, caffeine, and nicotine consumption. The Work Load Questionnaire consisted of nine short answer questions concerned with recovery time between rotations, work schedules/habits/hindrances, work load levels, and assessment of current sleep management plans.

Synthetic work task (SYNWORK1). Staff members' work performance was assessed using a computerized synthetic work task called SYNWORK1 (Elsmore, 1994). The SYNWORK1 program was not designed to simulate any particular job. According to Elsmore (1994), however, it does contain elements common to a number of watch-standing jobs. It also contains two characteristics of real work performance: the presentation of concurrent tasks and explicit assignment of outcomes for component task performance. The program allows the researcher to vary the difficulty levels of component tasks, the payoff matrix for component task performance, and choice of presentation of component tasks by themselves or in any combination to approximate key aspects of targeted jobs. The program is entirely mouse-based, thus allowing subjects' attention to focus exclusively on the display screen.

During a standard work session, the PC screen is divided into four quadrants or "windows". A small window in the center of the screen is used for displaying a composite "score" for performance on all of the subtasks. Auditory feedback is provided throughout the session. Correct responses (those producing points) are followed by a high-pitched "squeaking" sound, and errors by a low-pitched "burping" sound. The individual's goal is to earn as many points as possible during the session. This requires that the individual develop a strategy for optimizing responses to the four tasks appearing concurrently on the screen. Each component task is described below.

The first task, the Sternberg Memory Task, appears in the upper left quadrant of the PC screen. For each session a list of six letters ("positive list") is chosen from the alphabet and displayed in upper case letters in a box at the top of the quadrant. The positive list is displayed for only 5 seconds, after which it is replaced by the words "RETRIEVE LIST". When this message is displayed, clicking the mouse on the list box results in the display of the list for another 5 seconds. A point penalty (10) is assessed for each list retrieval. An equal-sized list ("the negative list") is also selected at the start of each session. Following each inter-trial interval (20 seconds), a sample letter is displayed in the box in the center of the quadrant. The individual's task is to indicate, by clicking the mouse on either the YES or the NO box at the bottom of the window, whether the letter is a member of the positive list or not. The sample disappears as soon as either a correct response or error is made. Points (10) are awarded for each correct response and deducted (10) for each error.

An Arithmetic Task is presented in the upper right quadrant. The task consists of adding two or three randomly selected numbers less than 1000. The individual's task is to calculate the answer by clicking on "+" and "-" boxes below each character of the answer, which is initially set to "0000". Clicking on a box labeled DONE at the bottom of the window results in the presentation of a new problem, addition of points (10) for correct answers, and deduction of points (10) for errors. There are no time limits for completion of this task.

The lower left quadrant contains the Visual Monitoring Task. In this task a pointer moves from the center of a 200-pixel scale towards either end at a constant rate of 5 pixels per second. Clicking the mouse on a box labeled RESET at the top of the window resets the pointer to the center. The individual's task is to prevent the pointer from reaching the end of the scale. Points are awarded for each reset according to a pre-set formula. The default maximum point value is 10. The closer the pointer is to the end of the scale at reset, the more points are awarded. Points (10) are deducted when the pointer reaches the end of the scale and remains there for one second, and additional points (10) are deducted each second the pointer stays at the end of the scale. Unlike the previous tasks, response omissions for the visual monitoring task are severely penalized.

In the lower right quadrant is the Auditory Monitoring Task. At periodic 5 second intervals a brief tone is sounded over the PC Speaker or over the headphones. The tone is either of two frequencies, low (931 Hz) or high (1234 Hz). The individual's task is to click the mouse in a box at the top of the window labeled HIGH SOUND REPORT following a high tone. High tones occur on 20% of the trials. Correct responses are those that occur following a high tone, prior to the next scheduled tone. All other responses are incorrect. Points are awarded (10) for each correct response, and deducted (10) for each error.

The SYNWORK1 program requires an IBM-compatible personal computer, a Microsoft-compatible mouse, and an EGA or better display. See Elsmore (1994) for additional details. For this study, SYNWORK1 was run on an IBM compatible 80386

computer with color VGA monitor and Sound Blaster compatible audio source with head phones.

Mood scale. An 11 item computerized sleepiness-mood scale was presented prior to the start of the SYNWORK1 session. Sleepiness was assessed using a revised six point version of the Stanford Sleepiness Scale with the following scale values: 1) Feeling active and vital; wide awake; 2) Functioning at high level, but not at full alertness; 3) Relaxed, awake, and responsive but not at full alertness; 4) A little foggy; starting to let down; 5) Beginning to lose interest in remaining awake; 6) Prefer to be lying down; fighting sleep; woozy.

The ten mood items included the following: Tense, Cheerful, Relaxed, Irritable, Energetic, Focused, Jittery, Dependable, Efficient, and Sluggish). Items were answered using a four point scale (1 = Not at all, 2 = Somewhat, 3 = Definitely, 4 = Extremely) based on how the individual felt at the particular time.

Apparatus

Activity monitors. Sleep-work cycles were measured using wrist-worn activity monitors. The activity monitors used were all the same, Model AMA-32, developed by Precision Control Designs, Inc., Fort Walton Beach, Florida. This model measures 4.45 x 3.48 x 1.27 cm., about the size of a diver's watch. The monitor has a memory capacity of 32 Kbytes. It is highly programmable, permitting user specification of frequency passband, threshold, and amplification factors. [See Elsmore and Naitoh (1993) for more details on parameter settings.] These monitors are very unobtrusive. The individual straps the monitor around the non-dominant wrist and forgets about it until it is replaced. Movements made by the individual generate an electrical voltage, producing a signal which is stored in an on-board memory. Activity is partitioned in "epochs" of time, usually 60 seconds in duration. For each epoch, the number of movements occurring is counted and stored. Depending on the monitor used and its configuration, approximately 22 days of data can be stored before data has to be down-loaded [See Elsmore and Naitoh (1993) for more details.] Activity data were computer scored for sleep-wakefulness and verified by an investigator. A record was scored as sleep if there were less than 20 counts per minute for five consecutive minutes. Activity-generated measures of sleep-wakefulness have been shown to correlate remarkably well ($r > .82$) with corresponding parameters scored from the polysomnagram (Cole, Kripke, Gruen, Mullaney, & Gillin, 1992).

Procedure

Researchers met with the staff members two months ahead of the scheduled rotation to begin initial testing and to ensure adequate time for train-up on the SYNWORK1 task. Participants were briefed on the major objectives of the research and given the opportunity to ask any questions about the equipment or tasks they would perform. All participants were then given consent/privacy act statements and the Sleep History Questionnaire to complete.

SYNWORK1 training and testing took place in a room adjacent to the TOC. Staff members trained individually. One of the staff members was recruited to serve as task monitor to ensure that all subjects were progressing satisfactorily in their training and completed the agreed number of trials (twenty 5 minute SYNWORK1 sessions) prior to the start of the rotation.

Initially, staff members were exposed to each of the four SYNWORK1 component tasks separately for a two-minute time period. After each component task had been presented separately, subjects were then presented with a two-minute version of SYNWORK1 with all tasks occurring simultaneously. This initial session took about 15 minutes to complete. Following this session, all train-up and experimental sessions were run for five minutes (with all four SYNWORK1 tasks occurring simultaneously).

The staff members were to complete one sleepiness-mood inventory and at least one SYNWORK1 session each day during the rotation. The sleepiness-mood inventory took approximately 2-3 minutes to complete.

One day prior to the start of the rotation, researchers distributed the activity monitors to the subjects. Subjects were monitored for 16 days which were broken into two phases: Insurgency (10 days), and Attack (6 days). On day 16, the activity monitors were collected from the subjects. Each subject then completed the Work Load Questionnaire.

Results

OPFOR Sleep History

Questionnaire responses from OPFOR battalion staff members indicated that they slept, on the average, 6 hours 36 minutes per night (SD = 52.6 minutes) when not on rotation. Sleep periods ranged from 5-8 hours. Staff members were asked to list the times of the day they felt most alert and those times they felt most sleepy. They were allowed to list no more than two separate times for alertness and sleepiness. From a relative standpoint, staff members were far less variable in their alertness estimates than with their sleepiness estimates. Standard deviations for sleepiness estimates were 2.4 to 3.4 times higher than those for the alertness estimates. In general, staff members tended to be most alert from approximately 0735-1035 and from 1510-1735. Staff members were most sleepy from approximately 1015-1135 and from 1405-1450. Sleepiness-alertness ratings followed a general cyclical pattern.

Eighty percent of the staff felt that they could use more sleep. Most staff members (80%) felt unrested after awakening. Eighty percent never or almost never take naps when not on rotation. On the average, staff members indicated that they could use an extra hour and 50 minutes sleep per day (SD = 23.4 minutes). Nap times ranged from 1 hour - 2 hours and 12 minutes.

During the rotation, staff members average, based on self-reports, 6 hours and 7 minutes sleep per day (SD = 73.2 minutes). Primary sleep periods are, for the most part, planned. There is a TOC shift schedule that is based on 12 hour day and night shifts in which no one does a shift without being off for at least 11 hours prior to the start of their shift. But, as one staff member noted, the emphasis is less on sleep management and more on time management. Napping during rotation is infrequent. Eighty percent of the staff indicated that they napped only 1-2 times per week while on rotation. Naps, when taken, averaged 44.4 minutes (SD = 19.2 minutes). The duration of these naps ranged from 18-60 minutes.

The use of stimulants, in the form of caffeine and nicotine, was reported. Staff members consumed approximately 3 cups/cans of coffee and/or other caffeinated beverages (soft drinks) per 24 hours during a rotation. At approximately 100 mg caffeine per cup of coffee and 50 mg caffeine per soft drink, staff members consumed roughly 250 mg of caffeine per day. This does not include any extra caffeine which may be present in certain headache pain products as buffering agents. Single dosages of from 300-600mg of caffeine are recommended for maintaining alertness in continuous operations (Belenky et al., 1994). Although no staff member smoked, 20% did use smokeless tobacco.

Characterization of Actual Sleep Periods

Total sleep time: Staff trends. The staff averaged 5.2 hours (SD = 1.9 hours) sleep per day. During the Insurgency phase, the battalion staff averaged, as a whole, 5.3 hours (SD = 1.9 hours) sleep per day. Sleep times ranged from 3.9 hours (Day 10) to 6.4 hours (Day 6). For the Attack phase, the staff averaged 4.9 hours (SD = 1.9 hours) sleep per day. Sleep times ranged from 3.5 hours (Day 16) to 6.2 hours (Day 14) during this phase (See Figure 1). Differences between phases were not statistically significant [$t(7) = .359$, n.s.]

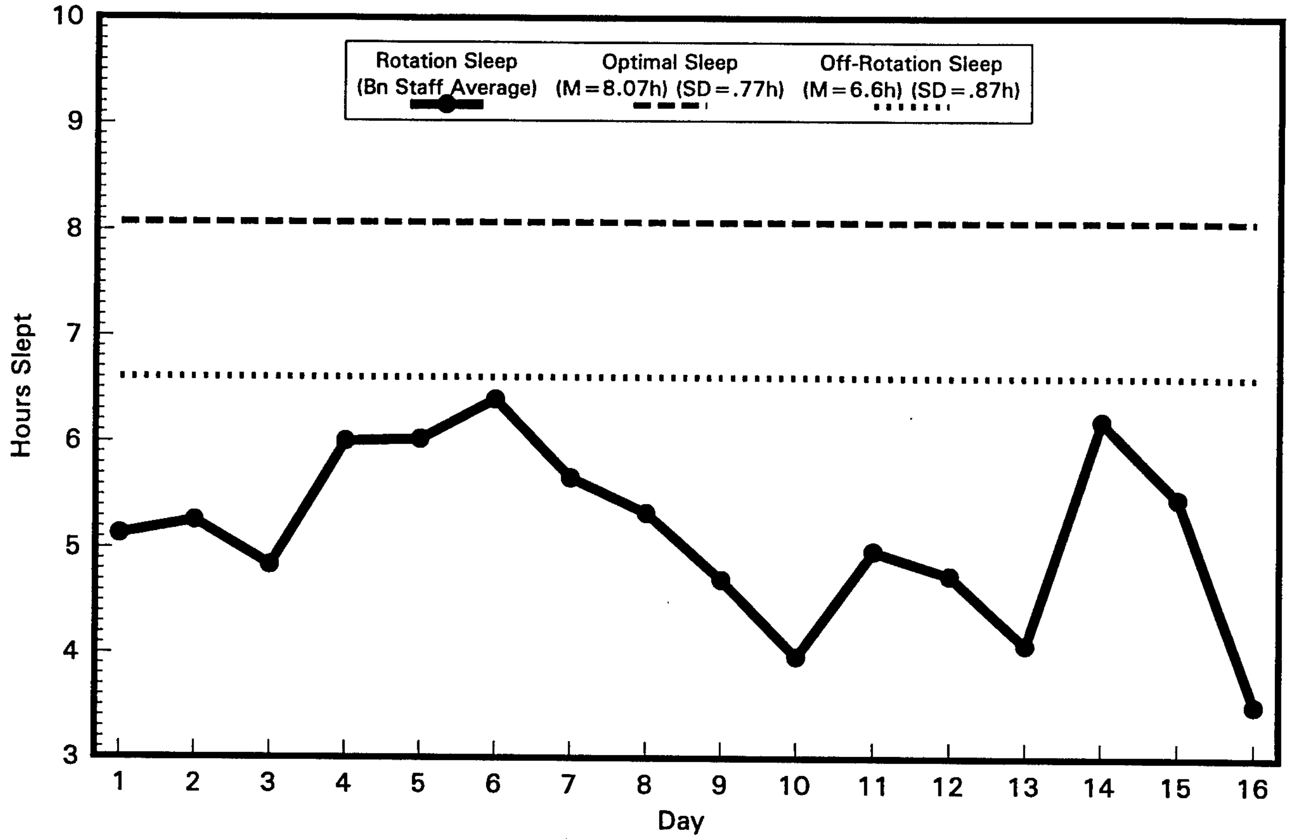

Figure 1. Average Time Slept by Battalion Staff vs Actual Sleep Requirements.

The staff averaged almost three hours less sleep (5.16 hours or 309.4 minutes) per day on rotation than what they indicated they needed for total or optimum recovery (8.07 hours or 484.2 minutes per day). Average off-rotation sleep periods were almost 90 minutes (396 minutes sleep per day) less than the stated optimum (See Figure 1).

Total sleep time: Individual trends. From an absolute standpoint, certain staff positions (XO, S3-Plans, S2), at least in this sample, received very little sleep across phases. Average sleep times ranged from 4.4 hours to 4.6 hours during the Insurgency phase. During the Attack phase sleep times ranged from an average of 3.7 hours to 4.5 hours sleep per day for these individuals (See Tables 1 and 2).

Table 1

Summary Characterization of Staff Sleep Periods - Insurgency Phase (Days 1-10)

	Number of Hours Slept/Day		Longest Uninterrupted Sleep Period/Day (Min)	
Subject	M	SD	M	SD
S1	6.03	1.24	57.0	15.4
S2	4.65	1.12	52.2	15.7
FSO	5.05	0.87	64.3	13.8
S3-Air	5.73	2.60	64.2	70.3
XO	4.42	1.55	38.0	9.1
S3 [a]	-----	----	----	----
S3-Plans	4.60	1.05	27.7	6.2
S4	3.95	1.18	33.5	7.5
S3-Train.	5.73	1.53	50.1	23.3
ADO	7.87	2.13	69.8	18.0

[a] Analyses could not be performed for any of the days during this phase due to equipment malfunction.
Note. Means based on 7-10 days of data for each subject. Missing days were the result of either equipment malfunction or incomplete data which could not be accurately analyzed.

Table 2

Summary Characterization of Staff Sleep Periods - Attack Phase (Days 11-16)

	Number of Hours Slept/Day		Longest Uninterrupted Sleep Period/Day (Min)	
Subject	M	SD	M	SD
S1	6.64	2.11	58.5	15.8
S2	3.71	1.75	32.3	19.7
FSO	4.69	1.40	55.7	17.7
S3-Air [a]	-----	-----	----	----
XO	4.46	2.19	36.2	18.8
S3	5.62	2.22	89.8	51.3
S3-Plans	4.25	1.50	30.7	9.5
S4	7.65	-----	193.0	----
S3-Train.	4.90	2.01	50.2	12.8
ADO	3.85	2.47	57.8	12.0

[a] Analyses could not be performed for any of the days during this phase due to equipment malfunction.
Note. Means based on 4-6 days of data for each subject except the S4, who had only one day of valid data. Consequently, the S4 was excluded from all comparisons with other staff members and any additional statistical analyses.

Statistical analyses of changes in individual staff member's sleep times between phases were performed using an interrupted time series analysis called ITSACORR (Crosbie, in preparation). Unlike other time series analysis procedures, ITSACORR does not require a long series, or set of data points, e.g., n = 50 per phase, as do some procedures, and it controls effectively for high levels of positive autocorrelation between scores. ITSACORR procedures are based on the interrupted time-series experiment (ITSE) model with specific modifications to provide better control of Type I error and acceptable power for small sample sizes, e.g., < 10 observations per phase. The results of these analyses showed, for the most part, no statistically significant differences between phases for individual staff members. The only exception was the S1, who got significantly [$\underline{F}(2,11) = 5.87$, $\underline{p} = .018$] more sleep during the Attack phase [M = 6.6 hours (398.7 minutes)/day]) than during the Insurgency phase [M = 6 hours (362 minutes)/ day]. (See Tables 1-2.) Analysis of the activity data for each soldier showed that sleep was not obtained in a single uninterrupted block. Instead, sleep periods were frequently broken into several periods. Interruptions in sleep were usually only a few minutes in duration. The longest uninterrupted sleep periods (mean times for individual staff members) during the Insurgency phase ranged from 27.7 minutes to 69.8 minutes. The overall average for the staff was 51.1 minutes (SD = 28.2 minutes) During the Attack phase the longest uninterrupted sleep periods ranged from 30.7 to 89.8 minutes. The staff average was 53.7 minutes (SD = 31.7 minutes) [See Tables 1-2].

<u>Sleep quality: Movement during sleep and sleep continuity.</u> The recuperative value of sleep is dependent not only on the duration of sleep, but the quality of sleep as well. Sleep quality was assessed by examining the restlessness (movement) of individual staff member's sleep and sleep continuity. Continuity refers to whether the individual obtains sleep in one block or smaller, fragmented bits over time. With regard to movement during sleep or restlessness (defined as > 5 < 20 movements per minute), an average of only 10.8% (SD = 4.7%) of the staff members' sleep could be classified as restless during the Insurgency phase. Restless sleep accounted for as little as 6.2% and as much as 19.3% of individual staff members' total sleep (See Table 3).

Restlessness was also low during the Attack phase, averaging 9.4% (SD = 5.2%) during this time. During this phase, restless sleep accounted for anywhere from 5.3% to 16.5% of an individual's total sleep (see Table 4). Daily fluctuation in the overall staff average over time was negligible. ITSACORR results indicated, with one exception, that staff members' restlessness/movement levels (during sleep) did not change significantly between phases. Figure 2 shows very little fluctuation in the overall staff average over time.

Table 3

Quality of Sleep Obtained by Battalion Staff Members - Insurgency Phase (Days 1-10)

	Percentage of Total Sleep Classified as Restless		Percentage of All Sleep Periods 10 Minutes or Less (Fragmented)	
Subject	*M*	*SD*	*M*	*SD*
S1	6.2	1.9	60.5	6.0
S2	8.5	2.8	59.3	13.7
FSO	12.1	3.0	63.5	11.9
S3-Air	9.5	3.2	69.2	7.0
XO	8.6	2.2	55.5	14.0
S3 [a]	----	---	----	----
S3-Plans	15.5	1.9	73.3	4.0
S4	19.3	2.9	76.1	8.8
S3-Train.	9.6	3.7	56.3	7.9
ADO	9.1	2.0	51.8	10.9

[a] Analyses could not be performed for any of the days during this phase due to equipment malfunction.
Note. Means based on 7-10 days of data for each subject. Missing days were the result of either equipment malfunction or incomplete data which could not be accurately analyzed.

Fragmented sleep, defined as the percentage of sleep consisting of sleep periods of 10 minutes or less, was fairly high. During the Insurgency phase, an average of 62.4% (SD = 12.5%) of the staff members' sleep could be classified as fragmented. Individual percentages ranged from an average of 51.8% to 76.1% per day (see Table 3).

Table 4

Quality of Sleep Obtained by Battalion Staff Members - Attack Phase (Days 11-16)

	Percentage of Total Sleep Classified as Restless		Percentage of All Sleep Periods 10 Minutes or Less (Fragmented)	
Subject	M	SD	M	SD
S1	7.0	2.7	63.4	7.2
S2	16.5	9.3	66.1	24.6
FSO	11.2	6.6	49.1	12.1
S3-Air [a]	----	---	----	----
XO	10.8	2.8	64.8	18.2
S3	9.6	1.8	57.8	12.9
S3-Plans	10.6	3.8	61.8	7.1
S4	8.3	---	75.0	----
S3-Train.	5.3	1.2	63.5	14.3
ADO	6.1	2.1	59.8	7.8

[a] Analyses could not be performed for any of the days during this phase due to equipment malfunction.
Note. Means based on 4-6 days of data for each subject except the S4, who had only one day of valid data. Consequently, the S4 was excluded from all comparisons with other staff members and any additional statistical analyses. Missing days were the result of either equipment malfunction or incomplete data which could not be accurately analyzed.

During the Attack phase, fragmented sleep accounted for, on the average, 60.8% (SD = 12.5%) of all sleep obtained by staff members. Individual percentages ranged from an average of 49.1% to 66.1% per day during this phase (see Table 4).

Fragmented sleep scores for the group (average) showed little change over time. ITSACORR results revealed no statistically significant differences in fragmented sleep obtained for any staff members between phases. See Appendix A for a graphic portrayal of each staff member's movement and fragmentation scores by day.

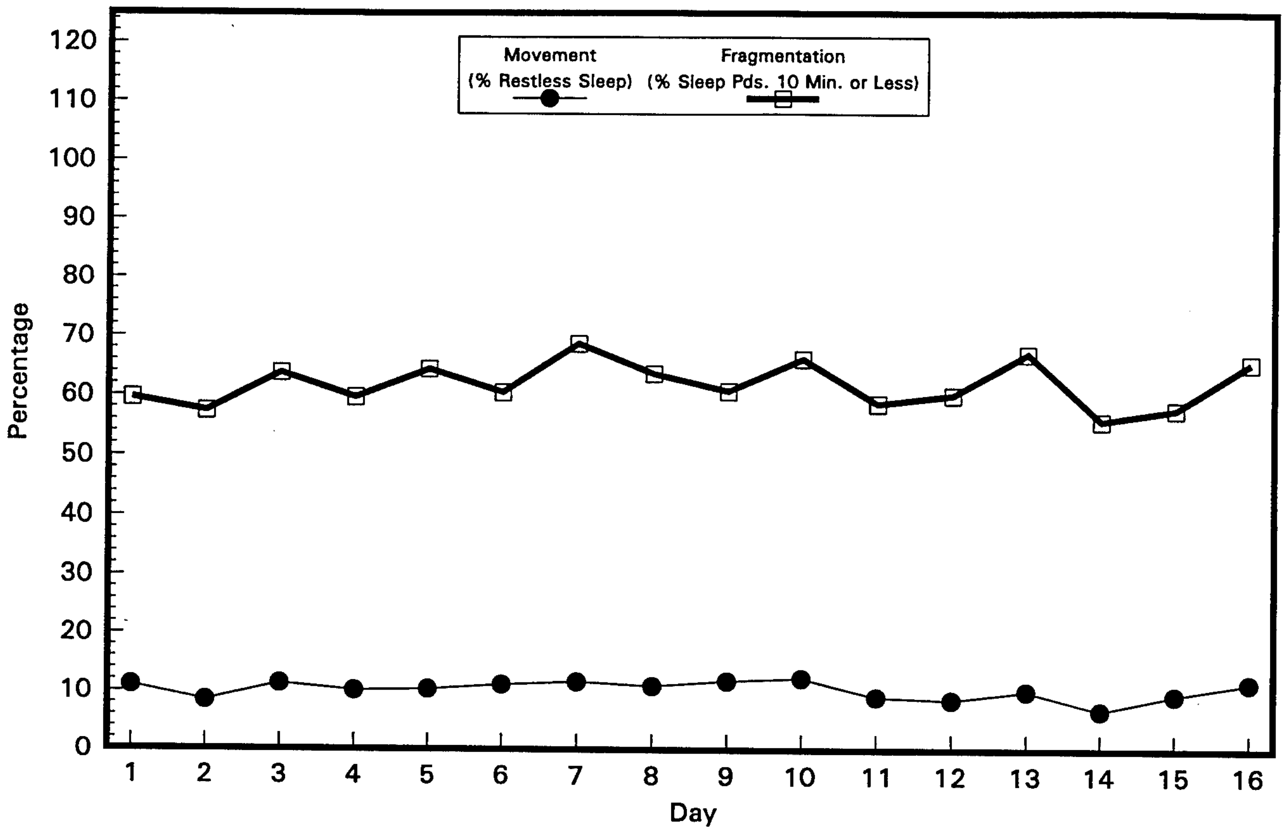

Figure 2. Quality of Sleep by Day - Average Battalion Staff Scores.

Battalion Staff Sleep Requirements

Staff trends. To assess the amount of sleep deprivation for each staff member, a normative sleep index (NSI) was created by calculating the ratio of actual sleep obtained to optimal sleep required for full recovery. This was done for each subject by day and phase (see Tables 5 and 6). Collapsing across subjects, mean indices were calculated for each day. During the Insurgency phase, the overall group average during this phase was .67 (SD = .25), indicating that the staff was obtaining, on the average, only about two-thirds of the sleep per day they said they needed to function at full effectiveness. Daily mean fluctuations in the NSI ranged from .82 on Day 6 to .49 on Day 10.

During the Attack phase, the overall average NSI score for the staff was .60 (SD = .23), indicating that the staff, as a whole, was obtaining only 60% of the sleep needed to function at peak effectiveness. Daily fluctuations in mean NSI scores ranged from .44 (Day 16) to .75 (Day 14).

Table 5

Ratio of Actual Sleep Obtained to Optimal Sleep Required for Full Recovery by Day (1.00 = Optimal Sleep Requirements Obtained) - Insurgency Phase

Rotation Day
(Insurgency Phase)

Staff Pos.	1	2	3	4	5	6	7	8	9	10		M	SD
S1	.55	.56	.66	.48	.92	.61	.60	.65	.69	.48		.62	.13
S2	.48	.88	.48	.65	.59	.53	.65	.55	.65	.35		.58	.14
FSO	.62	.46	.60	.69	.67	.62	.67	.62	.36	.64		.59	.10
S3-Air	.67	.80	.50	.68	.76	1.72	.66	.77				.82	.38
XO	.57	.42	.43	.92	.48	.33	.72	.61	.72	.33		.55	.19
S3 *													
S3-Plans	.88		.49	.48		.63	.55	.56	.51	.51		.58	.13
S4	.63	.66	.44	.64	.49	.64	.22	.47	.39	.36		.49	.15
S3-Trn.	.62	.79	.62	1.18	.97	1.00	1.07	.70	.55	.70		.82	.22
ADO	.76	.75	1.18	1.13	1.11	1.29	1.28	1.08	.72	.54		.98	.27
Mean	.64	.66	.60	.76	.75	.82	.71	.67	.58	.49		.67	---
SD	.12	.17	.23	.26	.24	.44	.30	.18	.14	.14		---	.25

* Empty cells indicate data was collected but could not be used in the analyses due to equipment malfunction.

Individual trends. NSI scores were then averaged across days. Mean NSI scores were calculated for each staff member, by phase, and are shown in Tables 5 and 6. During the Insurgency phase, the S4, XO, S3-Plans, S2, and FSO were the most sleep deprived based on their self-reported sleep needs, and how much sleep they actually obtained during this phase. These individuals received, on the average, anywhere from 49% (S4) to 59% (FSO) of their daily sleep requirements. The S3-Air, S3-Training and ADO were the least sleep deprived, obtaining, on the average, 82% (S3-Air and S3-Training) to 98% (ADO) of their daily sleep requirements.

Table 6

Ratio of Actual Sleep Obtained to Optimal Sleep Required for Full Recovery by Day (1.00 = Optimal Sleep Requirements Obtained) - Attack Phase

Rotation Day
(Attack Phase)

Staff Pos.	11	12	13	14	15	16		M	SD
S1	1.03	.64	.68	.78	.62	.37		.68	.22
S2	.39	.61	.61	.52	.60	.05		.46	.22
FSO	.39	.51	.52	.82	.66	.40		.55	.17
S3-Air *									
XO	.67	.64	.01	.78	.66	.58		.56	.27
S3	.78	.65	.50	1.00	.80	.25		.66	.26
S3-Plans	.48	.18	.62	.69	.63	.59		.53	.19
S4		.96						.96	---
S3-Trn.	.62.	.60	.68	.71	.35	1.23		.70	.29
ADO	.40	.41	.35	.69	.97	.08		.48	.31
Mean	.59	.58	.50	.75	.66	.44		.60	---
SD	.23	.21	.22	.14	.17	.38		---	.23

* Empty cells indicate data was collected but could not be used in the analyses due to equipment malfunction.

During the Attack phase, the S2 (46%) and ADO (48%) were the most sleep deprived. They were followed by the S3-Plans (53%), FSO (55%), and XO (56%). The S3-Training (70%), S1 (68%), and S3 (66%) were the least sleep deprived. The S4 had only one valid day of data which could be scored during this phase. With the exception of the S1, ITSACORR results revealed no statistically significant differences in staff members' NSI scores between phases. The S1 obtained significantly more of his sleep requirements during the Attack phase (68%) than he did during the Insurgency phase (62%), $\underline{F}(2,11) = 5.87$, $\underline{p} = .018$.

Comparison of the activity patterns of the individual staff members showed that the S2, S3-Plans, FSO, and XO were the most sleep deprived across phases. For other staff members, such as the ADO, sleep patterns changed radically across phases, going from sleep during the evening (Insurgency) to greatly reduced sleep periods obtained primarily during the day (Attack). The activity data showed that some staff members' sleep was far less fragmented than others. This was reflected in the fragmentation scores (Tables 3 and 4).

OPFOR Work Load Levels

Sixty percent of the staff felt that their work load was excessive. Staff members indicated that they needed, on the average, 2.75 days [(SD = 2.30 days) (Range = 0-10 days)] for full recovery from the effects of the rotation. Most staff members (70%) felt that there should be more recovery time between rotations (an extra 3-7 days). Some staff members felt that work loads could be reduced by (better) distributing duties to others, utilizing staff members more efficiently, adding more officers/NCOs to pull duty, lightening rotational and unit requirements, and increasing the planning time between rotations.

SYNWORK1 Performance

Inspection of the SYNWORK1 data files indicated that only four of the ten staff members completed enough trials to be considered even marginally acceptable for further analyses. The four subjects, S3-Plans, XO, S1, and FSO, all had completed six 5 minute training sessions, and at least three sessions for each phase. ITSACORR procedures were performed on each of the four SYNWORK1 subtasks (Sternberg Memory, Arithmetic, Visual and, Auditory Monitoring), as well as on a Composite score for each of the four staff members.

ITSACORR results revealed no significant differences between phases in the data for the S3-Plans and the FSO. For the XO, significant [$F(2,7) = 7.15$, $p = .02$], phase differences were obtained for the Visual Monitoring task, with performance improving significantly during the Attack phase relative to the Insurgency phase. The S1 obtained significantly [$F(2,9) = 5.38$, $p = .03$] higher Composite scores during the Attack phase than during the Insurgency phase. Tables 7-10 show the mean scores for each phase by staff member.

There were differences in performance stability among staff members. The S3-Plans, while improving his overall score across phases, showed increased variability in his responding across time for all four SYNWORK1 tasks. The standard deviation for the S3-Plans' Composite score for the Attack phase was nearly six times the size of his Composite score standard deviation during the Insurgency phase (See Table 7). It should be noted that during the Insurgency phase, the S3-Plans' sleep was far more fragmented (mean percent of total sleep that was fragmented = 73.3%) than the other staff members' sleep (XO = 55.5%; S1 = 60.5%; and FSO = 63.5%). For the other staff members, performance stability improved across phases. In each case, performance stability improved on four of the five SYNWORK1 measures (See Tables 8-10).

Mean SYNWORK1 composite scores increased over phases for each staff member. In each instance, these improvements can be attributed primarily to sizable increases in Arithmetic subtask scores (Mean increase = 38.3 points, Range = 21.2-56.7 points). (See Tables 7-10.)

Table 7

SYNWORK1 Performance Trends Across Phases: S3-Plans

Staff Position: S3-Plans	Insurgency Phase Sessions = 3	Attack Phase Sessions = 6
Composite Score	M = 479.3 SD = 16.2	M = 551.5 SD = 94.1
Sternberg Memory	M = 86.7 SD = 37.8	M = 116.7 SD = 39.3
Arithmetic	M = 163.3 SD = 25.2	M = 220 SD = 46.9
Visual Monitoring	M = 139.3 SD = 3.8	M = 131.5 SD = 14.0
Auditory Monitoring	M = 90.0 SD = 10.0	M = 83.3 SD = 26.6

Table 8

SYNWORK1 Performance Trends Across Phases: XO

Staff Position: XO	Insurgency Phase Sessions = 8	Attack Phase Sessions = 4
Composite Score	M = 699.1 SD = 109.1	M = 715.0 SD = 63.7
Sternberg Memory	M = 135.0 SD = 17.7	M = 125.0 SD = 37.8
Arithmetic	M = 326.3 SD = 83.8	M = 347.5 SD = 41.1
Visual Monitoring *	M = 132.9 SD = 10.0	M = 137.5 SD = 2.1
Auditory Monitoring	M = 105.0 SD = 20.7	M = 105.0 SD = 19.1

* $P < .05$

Table 9

SYNWORK1 Performance Trends Across Phases: S1

Staff Position: S1	Insurgency Phase Sessions = 7	Attack Phase Sessions = 7
Composite Score*	M = 677.4 SD = 81.6	M = 726.0 SD = 57.6
Sternberg Memory	M = 141.4 SD = 15.7	M = 138.6 SD = 10.7
Arithmetic	M = 321.4 SD = 54.6	M = 368.6 SD = 42.2
Visual Monitoring	M = 106.0 SD = 28.5	M = 110.3 SD = 19.8
Auditory Monitoring	M = 108.6 SD = 10.7	M = 110.0 SD = 12.9

* $p < .05$

Table 10

SYNWORK1 Performance Trends Across Phases: FSO

Staff Position: FSO	Insurgency Phase Sessions = 8	Attack Phase Sessions = 3
Composite Score	M = 612.8 SD = 79.9	M = 649.0 SD = 75.0
Sternberg Memory	M = 120.0 SD = 32.1	M = 116.7 SD = 30.5
Arithmetic	M = 255.0 SD = 49.3	M = 283.3 SD = 80.8
Visual Monitoring	M = 127.8 SD = 16.6	M = 129.0 SD = 10.4
Auditory Monitoring	M = 110.0 SD = 15.1	M = 120.0 SD = 0.0

<u>Mood Changes</u>

Mood items were also analyzed for the S3-Plans, XO, and S1 using the ITSACORR procedure. The FSO did not complete a sufficient number of sessions during the Attack phase which could be validly analyzed using this procedure. With only two exceptions, the

analyses showed no significant changes in mood state across phases (See Appendix B). Variability in ratings increased for many items across phases. Ratings for sleepiness, focused, efficient, and sluggish showed increasing variability over time for all staff members (S3-Plans, XO, S1).

Discussion

The results from this research showed OPFOR battalion staff members did not receive the requisite amount of sleep necessary to function at optimal effectiveness during rotation. The staff obtained almost three hours (174.8 minutes) less sleep per day, on the average, than they indicated they needed for full recovery. Off-rotation sleep, while longer in duration, averaged almost 90 minutes less per day than stated requirements.

Optimal sleep requirements for battalion staff members averaged 8.07 hours [(484.2 minutes) SD = .77 hours (46.2 minutes)]. This is consistent with the sleep needs for the majority of the general population (7.5 - 8.5 hours sleep per day).

Sleep Quality

In terms of sleep quality, the results are somewhat mixed. Movement or restlessness was fairly low throughout the rotation. However, the continuity of sleep was frequently broken, though broken for only minutes at a time in many instances. While it is difficult to know if the break in sleep, was, in fact, a full awakening, i.e., movement and verbal response; or simple postural adjustment, an individual does not have to be actually awakened to dilute the recuperative effects of sleep. Fragmentation with no obvious behavioral manifestation (a simple change in the electroencephalogram - EEG) can, by itself, destroy the recuperative value of sleep (Belenky, et al., 1994).

According to FM 22-9, Soldier Performance in Continuous Operations, the keys to enhancing the recuperative power of sleep are duration and continuity. This research shows that battalion staff members did not obtain sleep of adequate duration, and when they did sleep it was generally fragmented in nature.

The next generation activity monitor will include additional software integrated into the module which will predict individual performance based on recent sleep history as measured by the monitor. These monitors can be accessed during an on-going rotation or operation. The information obtained will indicate current sleep-work patterns, performance effectiveness levels, and how much sleep will be required by all personnel to improve performance and increase the probability of a successful operation (Belenky, 1995).

In the interim, activity patterns can be summarized and feedback provided to individual staff members, and the staff as a whole to assist the staff in developing optimal sleep-work schedules for the future. Subjective data obtained from questionnaires can also be

useful. For example, one item on the Sleep History Questionnaire focused on identifying peak alertness times for staff members. As was noted earlier, distinct alertness and sleepiness periods can be identified. Again, this background information can be useful in planning sleep-work schedules, and may be useful in prioritizing certain tasks or activities.

Performance and Mood Changes Over Time

The poor quality sleep obtained by the staff members did not seem to affect performance as assessed by the SYNWORK1 task. While the SYNWORK1 performance data did not conclusively show any associated decrements in cognitive performance, there is ample research showing that increasing sleep loss does lead to degraded performance (See FM 22-9 for a brief summary of the varied effects of sleep loss).

As can be seen from Table 7, the S3-Plans' overall mean composite score, while improving over time, became increasingly variable over phases. In contrast, the variability in the mean composite scores of the other staff members either decreased substantially or remained relatively consistent over time. Although the XO and FSO were some of the more sleep deprived staff members, along with the S3-Plans, the data point again to the importance of individual differences in adapting to sleep loss. While it may appear, at first, that the S3-Plans' performance was consistent with the two other similarly sleep deprived staff members, the increased variability in responding on the S3-Plans' part, suggests otherwise and is consistent with how performance degrades in such situations.

In general, relying on the average score obtained on a task over time as indicative of performance capability can be misleading. As F. W. Hegge and T. F. Elsmore (personal commmunication, July 29, 1994) note, signs of performance impairment in continuous operations are revealed more in lapses in performance and increased variability in responding by the individual. These individuals believe that by focusing only on mean differences, particularly at the group level, important changes occurring within the individual may be masked. In an operational setting, predictability of individual performance is critical. Commanders need to know who is at risk, at which time(s), and for how long.

For tasks such as SYNWORK1 to be more informative, adequate train-up time and multiple assessments (3-4) per day at specific time intervals (to detect circadian effects and more completely assess individual variability in responsiveness) are required. Although this was the intent, once the researchers left the TOC site, and the preparation/activities for the rotation became more intense, SYNWORK1 sessions dropped almost to zero for many staff members. Once the rotation started, participation on the SYNWORK1 task was haphazard. Similarly, mood also needs to be consistently measured at multiple times throughout the day. Only then will it be possible to accurately detect and assess the key indicators of performance impairment as noted earlier by Hegge and Elsmore (1994).

Recommendations

Sustaining Staff Performance

Better distribution of staff work load. In operational settings, either simulated, like JRTC, or actual combat, sleep loss will occur. The solutions for minimizing sleep loss effects may vary, depending on the unit. Interviews conducted with staff members and senior officers suggested that some of the problems leading to sleep loss and excessive work load are due to inefficient utilization of staff/TOC resources. Staff work loads can be reduced by better distribution of duties. Recent observations (CALL, May, 1995) by O/Cs at the National Training Center indicate that certain staff positions, e.g., XO and S2 are over utilized; often these individuals end up performing tasks that can be done equally well by other staff members. The results from this research indirectly confirmed these findings by clearly showing that the XO and S2, were two of the most sleep deprived staff members during the rotation.

As was noted earlier, XOs and battle captains attempt to accomplish many TOC tasks, with little or no assistance from the NCOs or enlisted personnel. The unwillingness to delegate these tasks to these individuals leads to inefficient operations, not to mention tired and ineffective staff members. Moreover, it prevents the XO or battle captain from doing his main job of integrating resources and synchronizing the fight. Lack of clearly defined roles and responsibilities is the major contributor to this problem. See FC 71-6, Battalion and Brigade Command and Control (March 1985), for a detailed list of duties and responsibilities for key personnel within the TOC.

CALL Newsletter 95-7 details the roles and responsibilities of four positions and discusses ways these individuals can be utilized more effectively than they are currently. These positions include the XO, battle captain, operations NCO/shift NCO, and Radio telephone operators (RTOs). Liaison officers can also be employed more efficiently. They can be particularly valuable in assisting the S2 in the planning process, specifically in the development of the IPB.

In summary, the keys to more efficient utilization of personnel begin with defining specific TOC functions and identifying which duty position will accomplish each task; and focusing home station training on those TOC activities where staff weaknesses exist (CALL, May, 1995).

Developing procedures for processing/managing information flow in the TOC. As fatigue increases, the ability to manage information and track the battle suffers. This finding could not be confirmed, however, in the present research. This would have required continual on-sight monitoring of TOC activities for the entire sixteen day rotation. Lack of resources, both human and financial, precluded this type of investigation. Nevertheless, a process-oriented investigation of staff procedures for distilling information and tracking the course of the battle flow in the TOC would be useful because of the critical nature of such activities.

As Belenky (1995) points out, once the TOC becomes overwhelmed with information requirements, demands, updates, etc., one of the first functions to disappear or be degraded is the ability of the staff to accurately analyze the situation. Inaccurate assessment of the situation can have disastrous effects, such as the Bradley Fighting Vehicle friendly fire casualties observed in Operation Desert Storm described by Belenky et al. (1994).

Conclusions

This preliminary research, together, with observations from the CTCs (CALL, May, 1995) suggests that to effectively sustain staff performance during continuous operations, better utilization of staff resources is critical. Once tasks and duties have been assigned to particular personnel, TOC specific tactics, techniques, and procedures identified by the commander and his staff must be thoroughly rehearsed.

In addition, commanders must take an active role in the development of unit sleep/work management plans (Chaisson, 1994). This includes educating unit members on the importance of sleep in combat operations and how to optimize the recuperative value of available sleep periods through specifically tailored unit sleep plans. The combination of knowledge and preparedness will allow the staff to work smarter so it can work more effectively.

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GRAPHIC SUMMARY OF INDIVIDUAL CHANGES IN SLEEP DURATION AND SLEEP QUALITY BY DAY

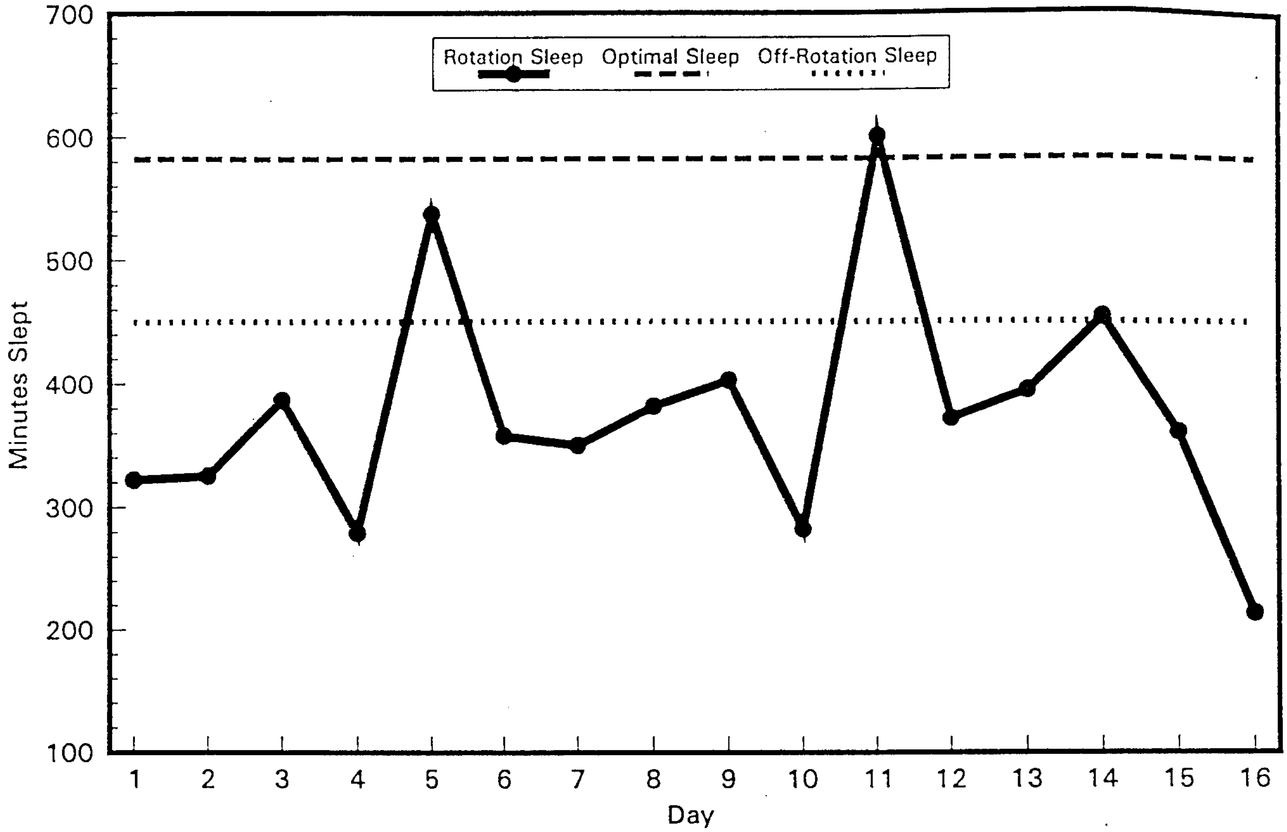

Figure A-1. Comparison of Rotation Sleep vs Individual Sleep Requirements - S1.

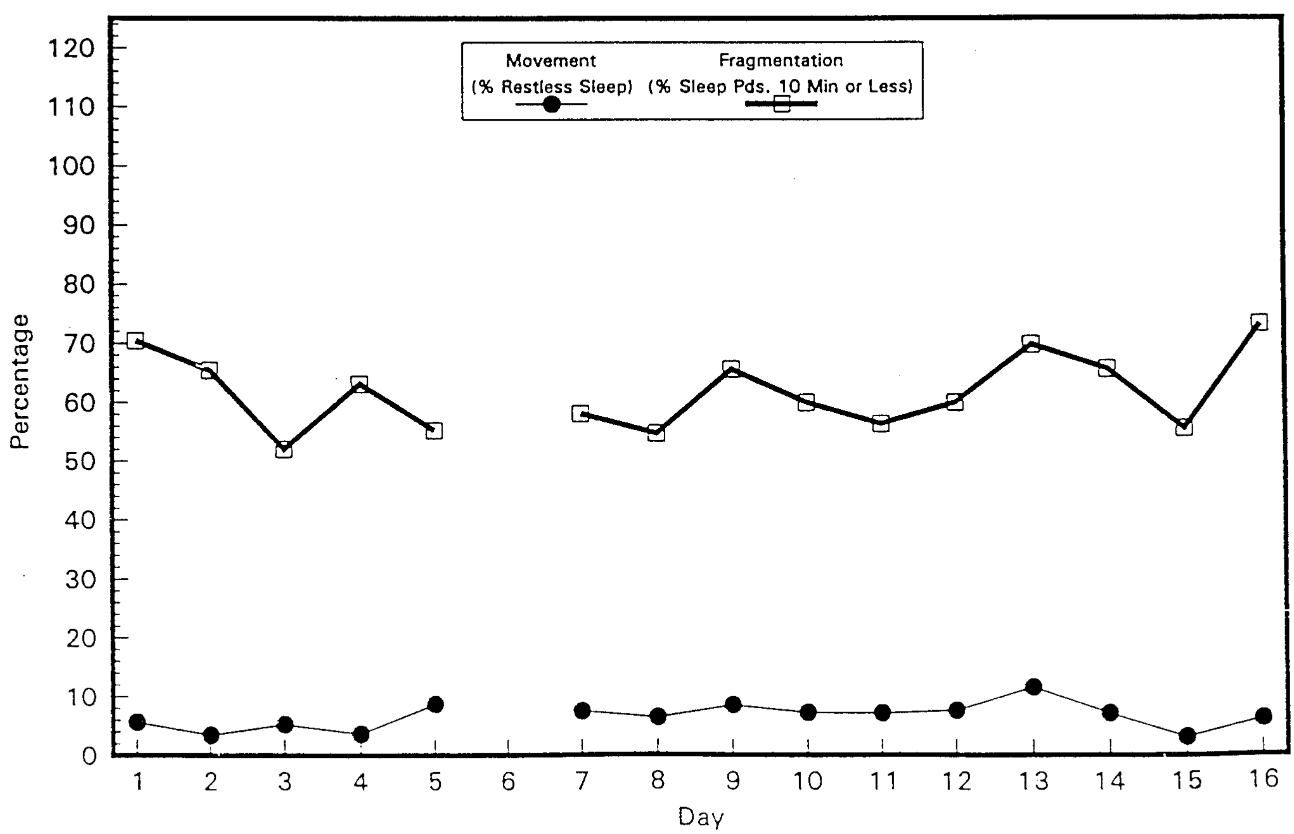

Figure A-2. Quality of Sleep by Day - S1.

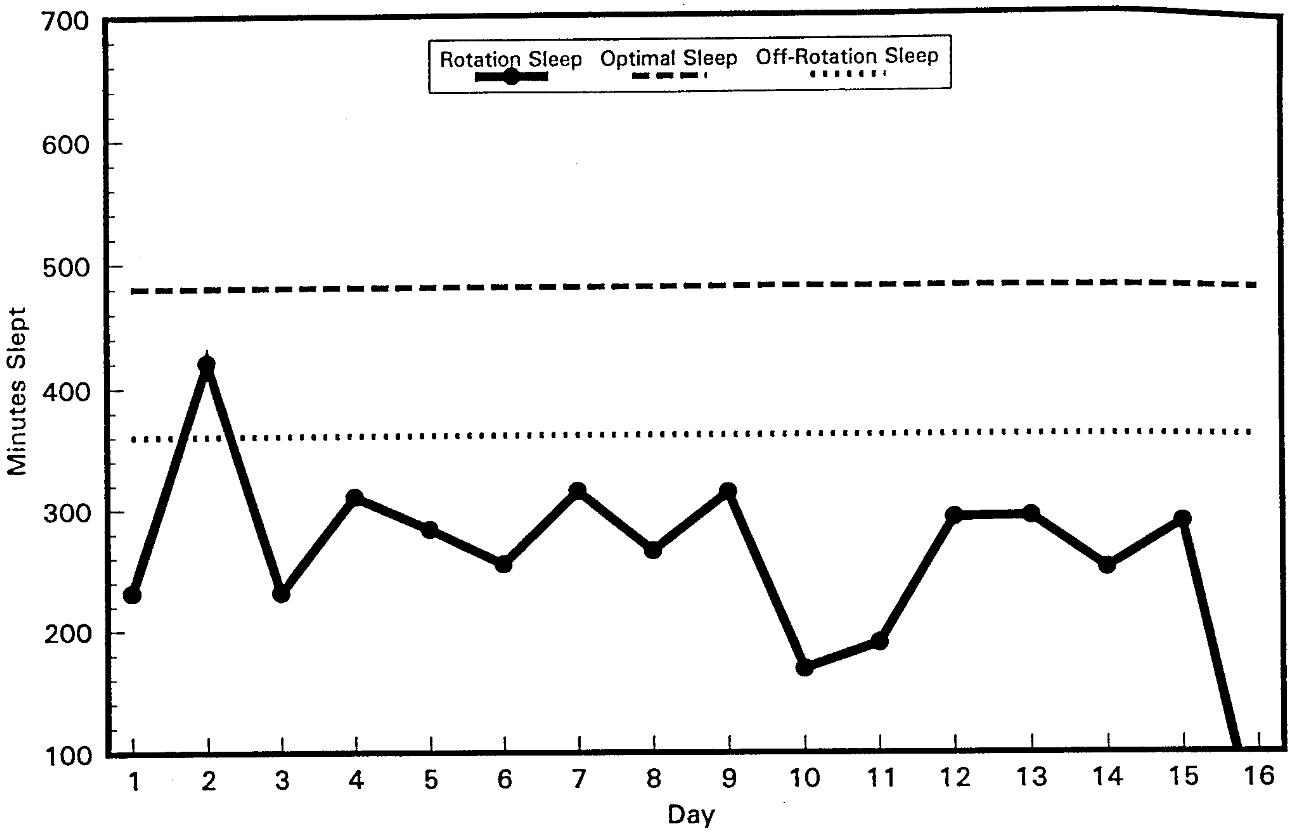

Figure A-3. Comparison of Rotation Sleep vs Individual Sleep Requirements - S2.

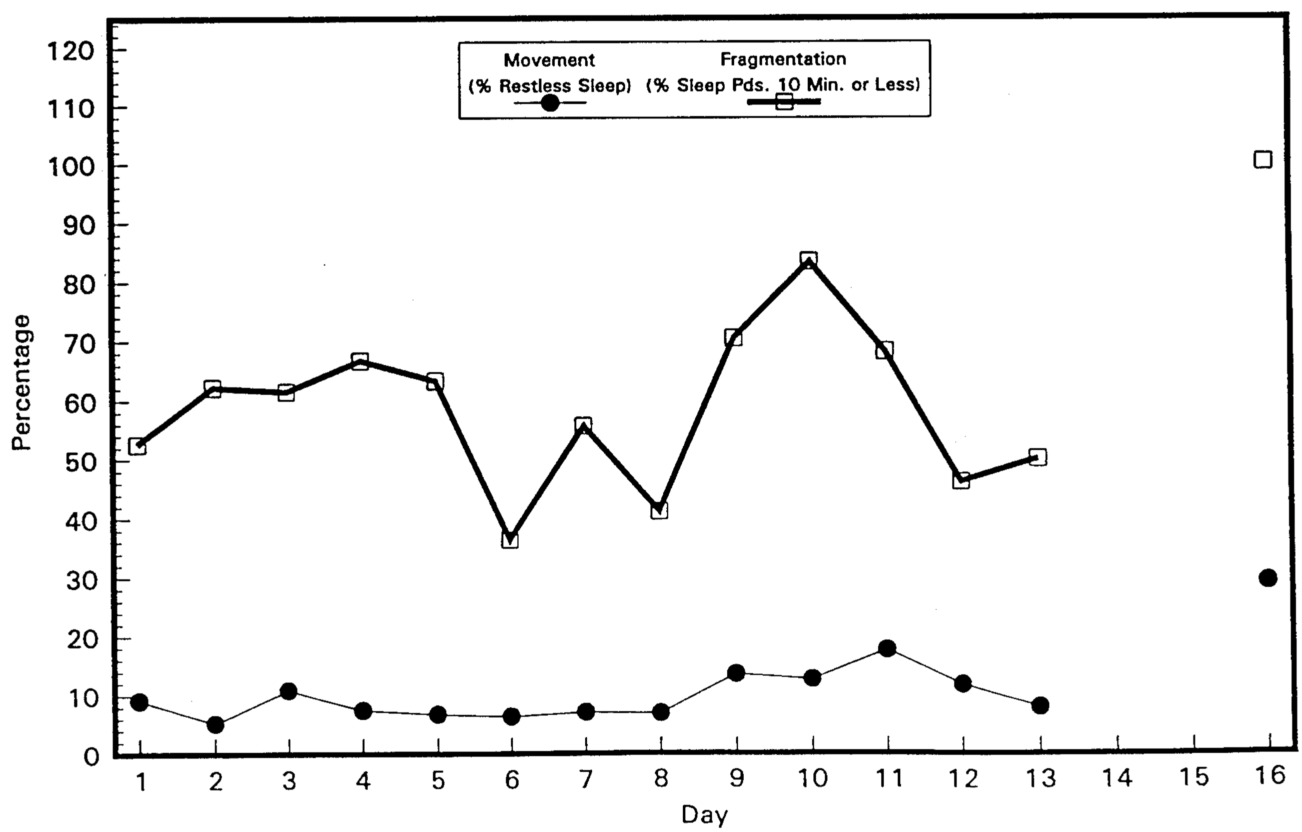

Figure A-4. Quality of Sleep by Day - S2.

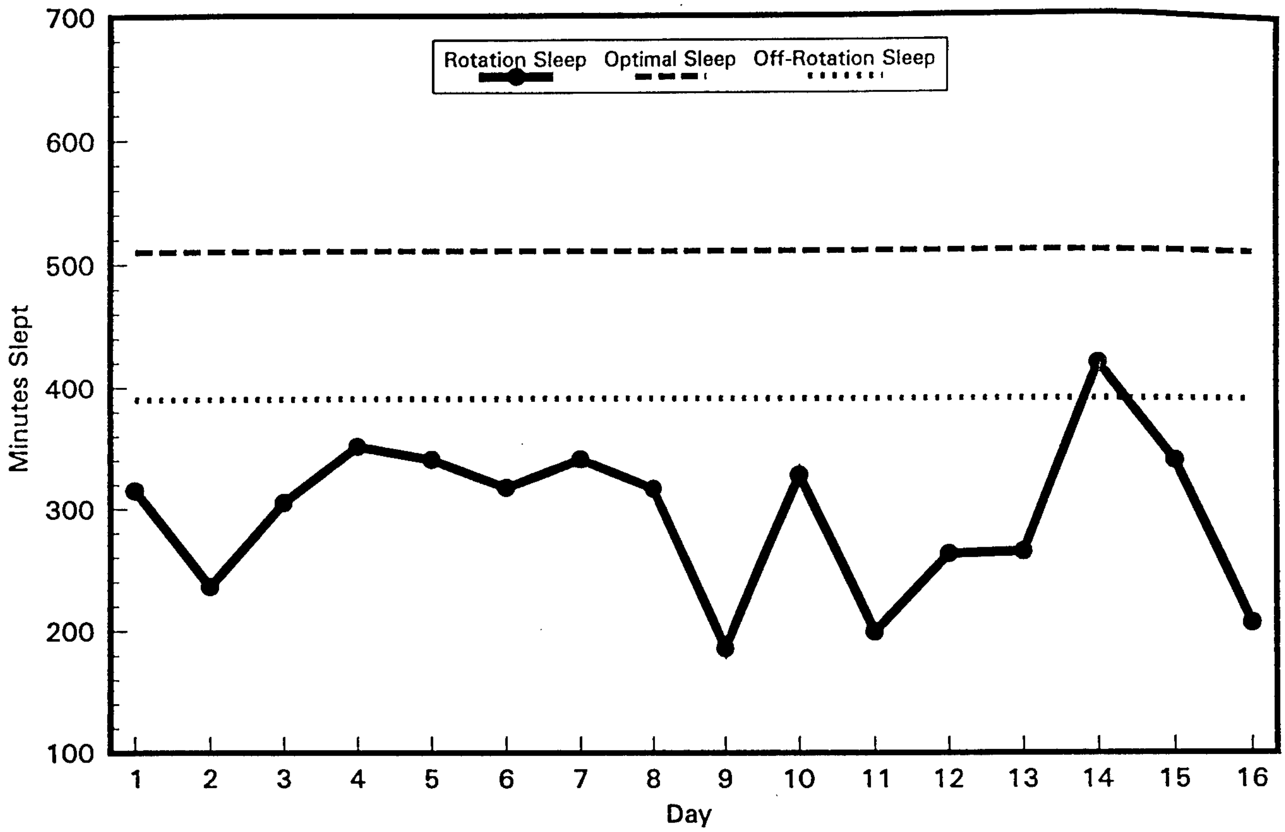

Figure A-5. Comparison of Rotation Sleep vs Individ. Sleep Requirements - FSO.

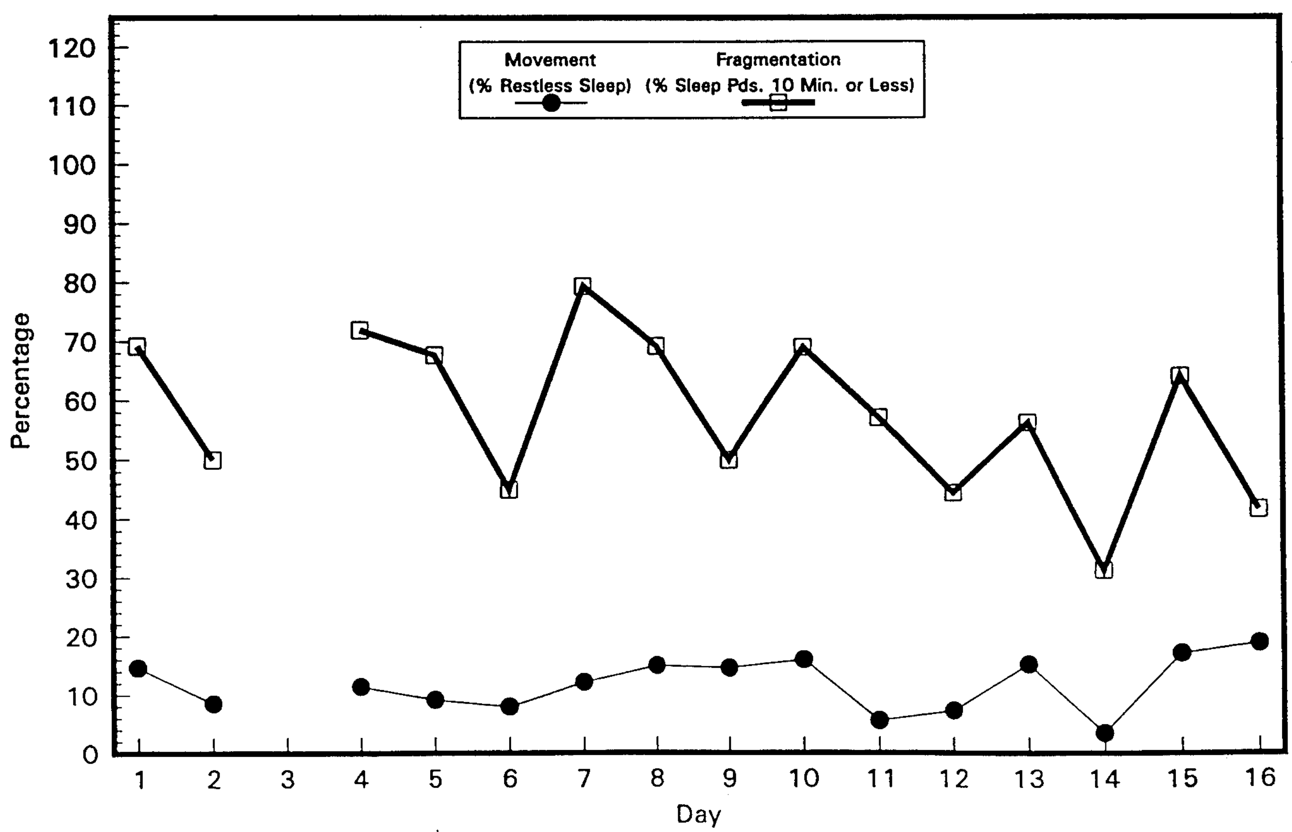

Figure A-6. Quality of Sleep by Day - FSO.

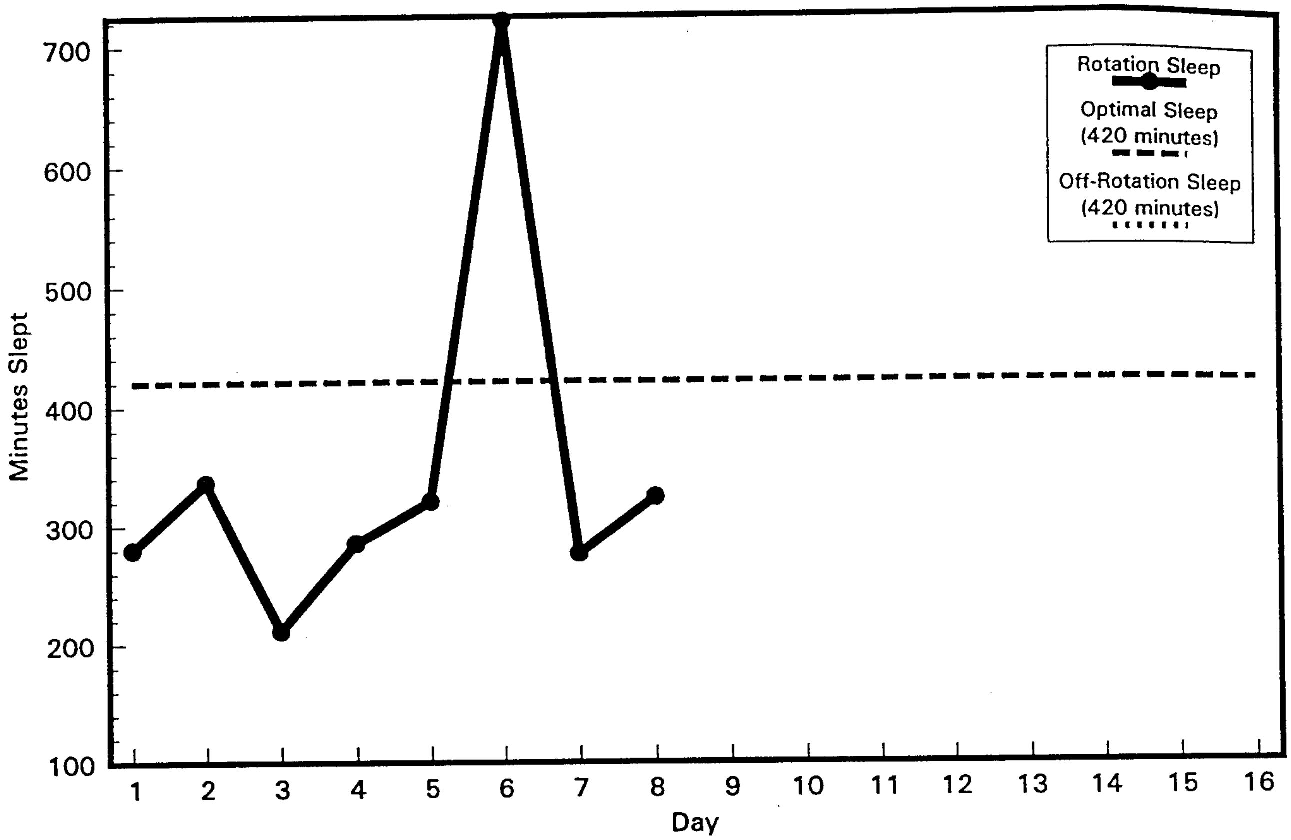

Figure A-7. Comparison of Rotation Sleep vs Individual Sleep Reqmnts. - S3-Air.

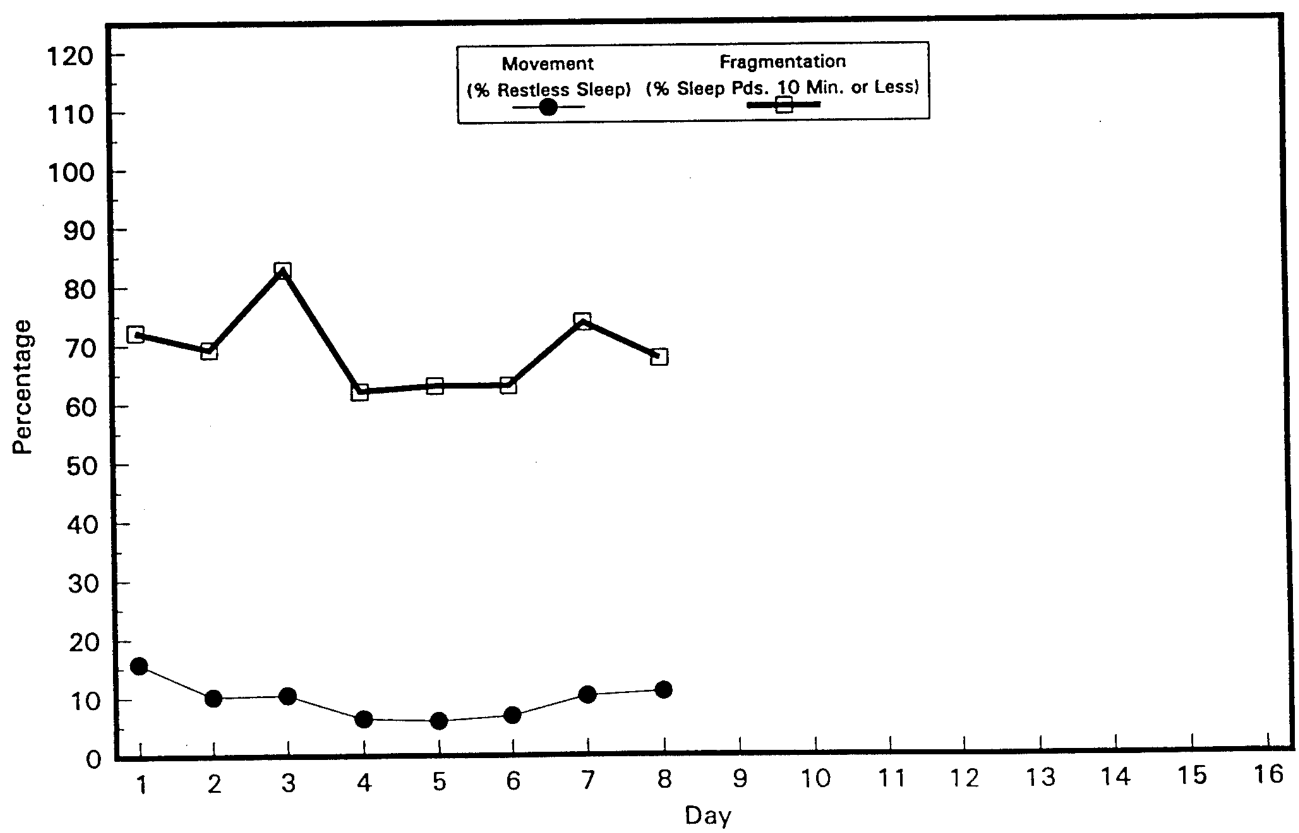

Figure A-8. Quality of Sleep by Day - S3-Air.

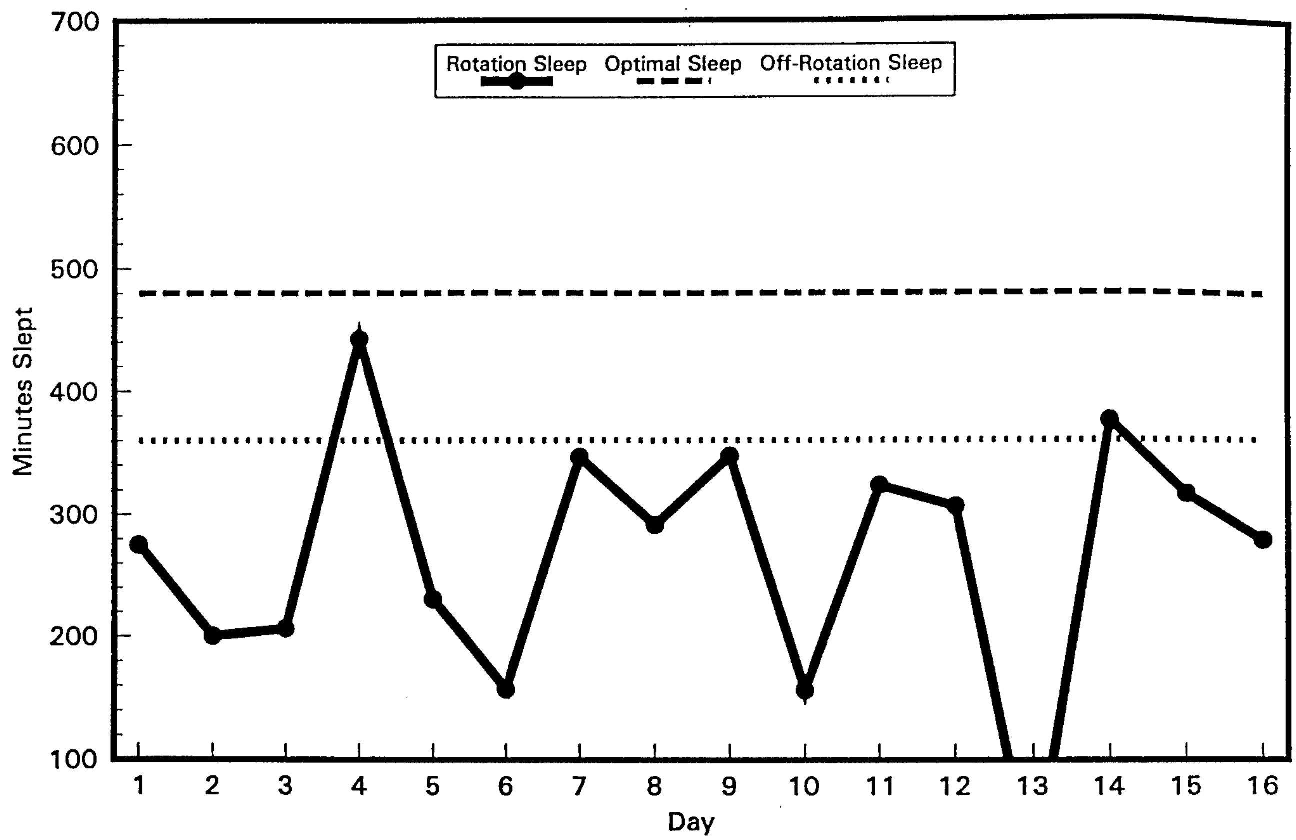

Figure A-9. Comparison of Rotation Sleep vs Individual Sleep Requirements - XO.

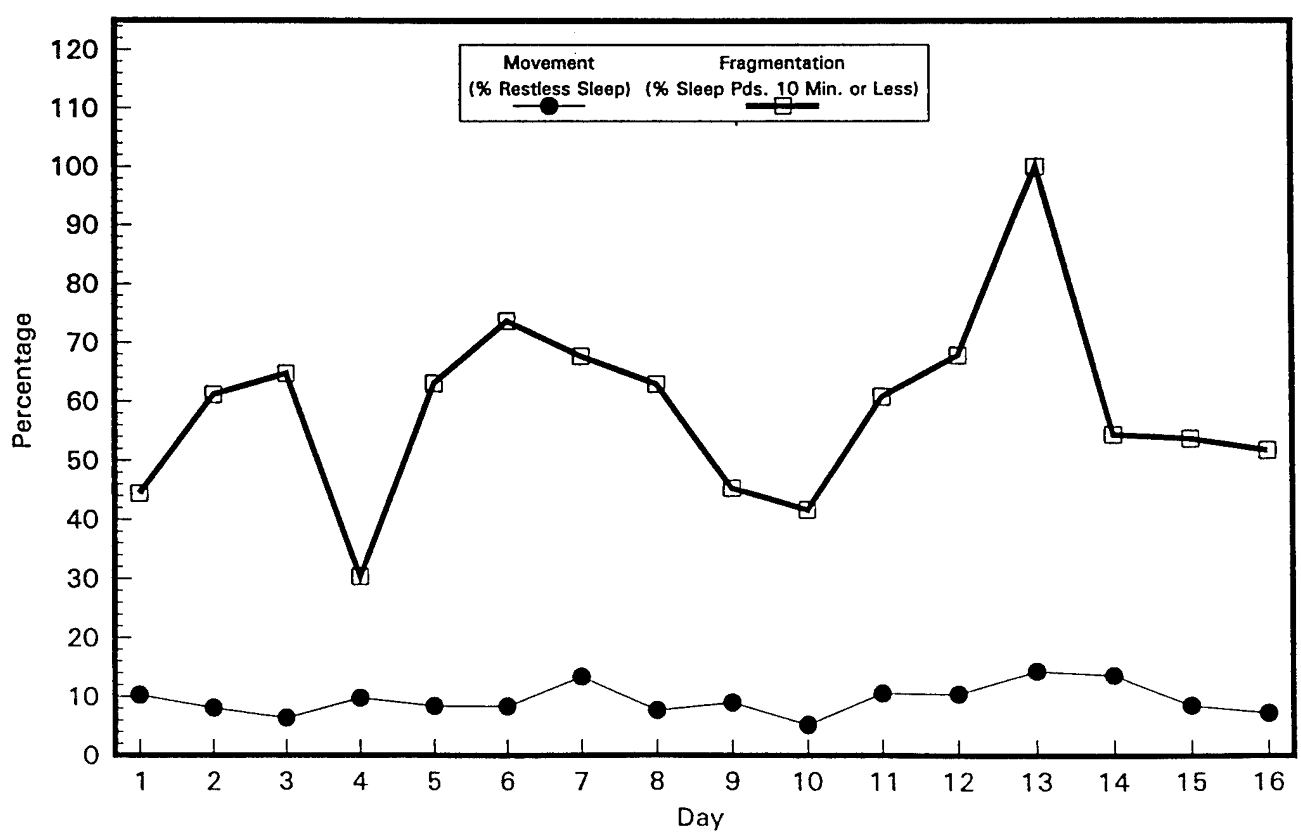

Figure A-10. Quality of Sleep by Day - XO.

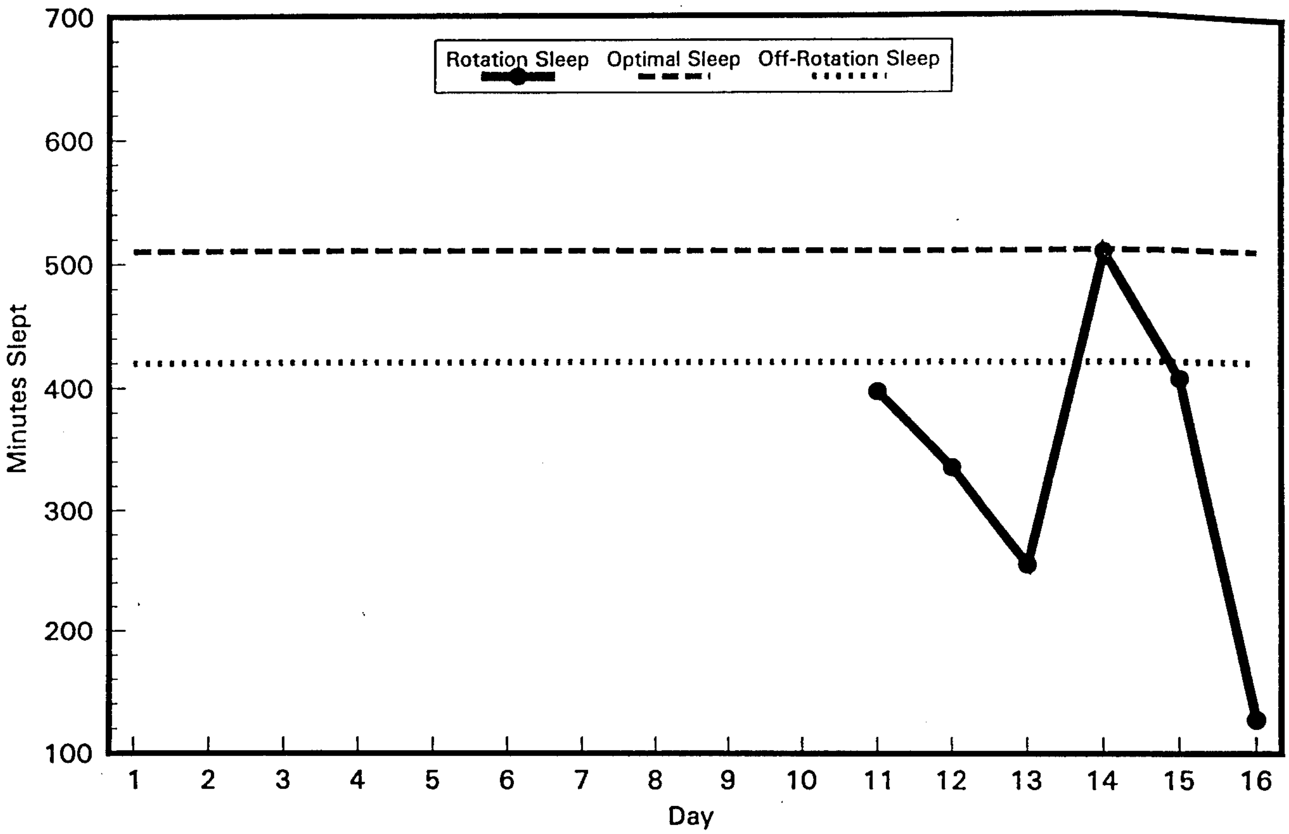

Figure A-11. Comparison of Rotation Sleep vs Individ. Sleep Requirements - S3.

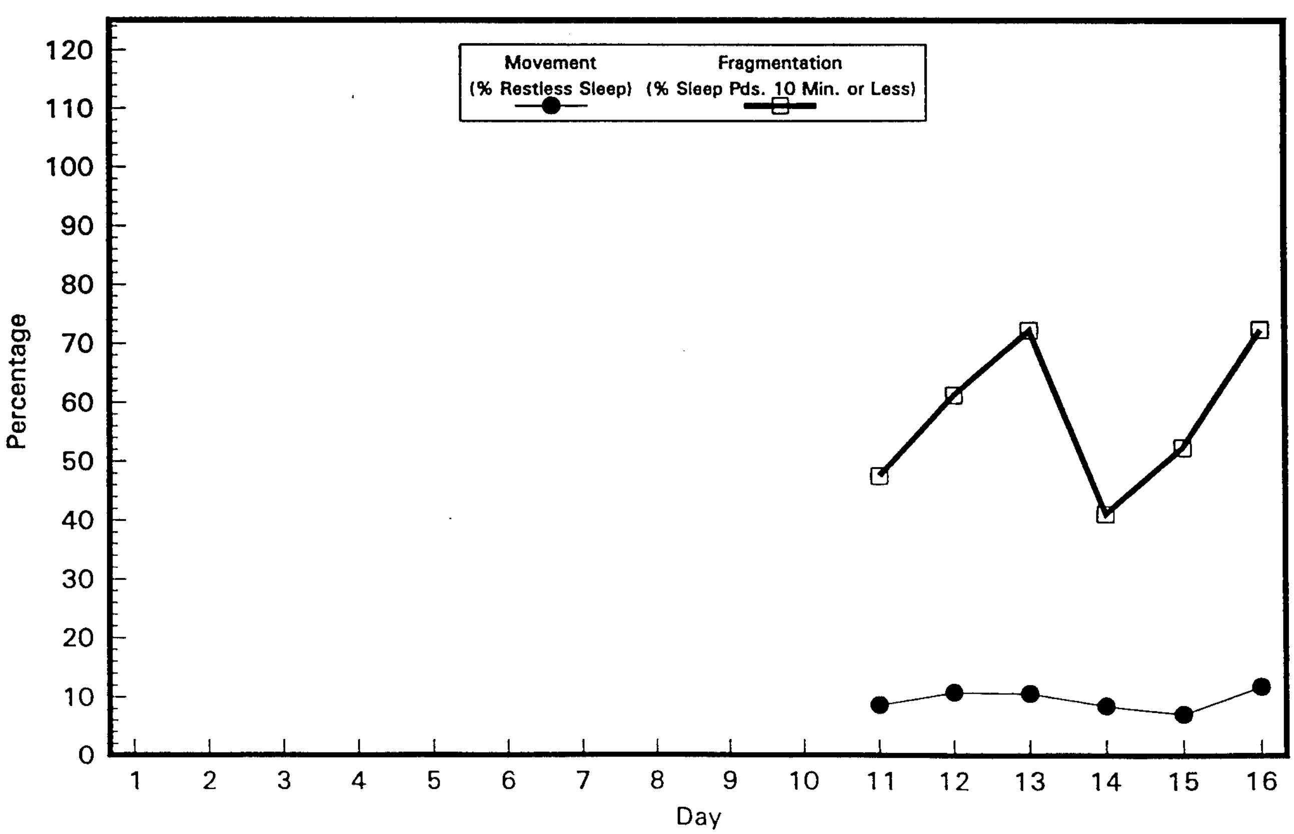

Figure A-12. Quality of Sleep by Day - S3.

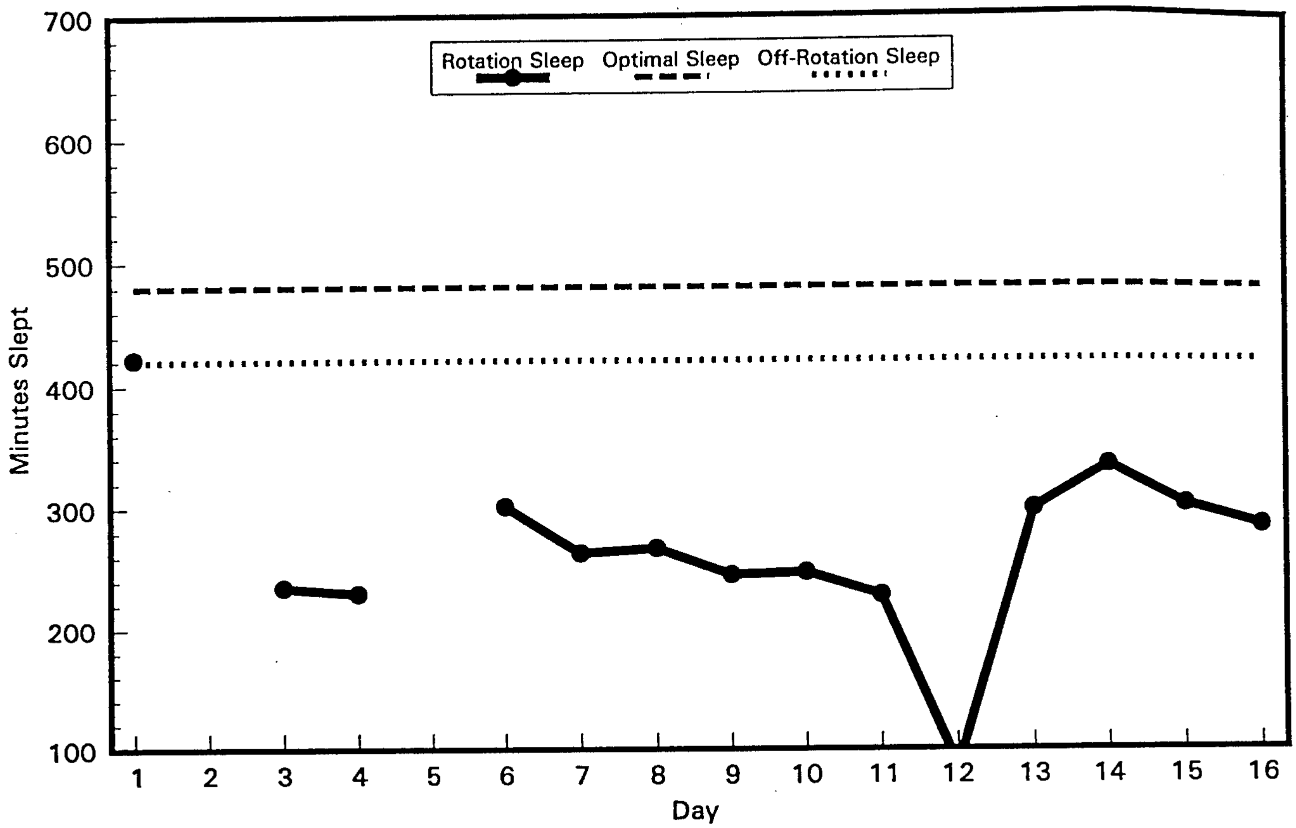

Figure A-13. Comparison of Rotation Sleep vs Individ. Sleep Reqmnts - S3-Plans.

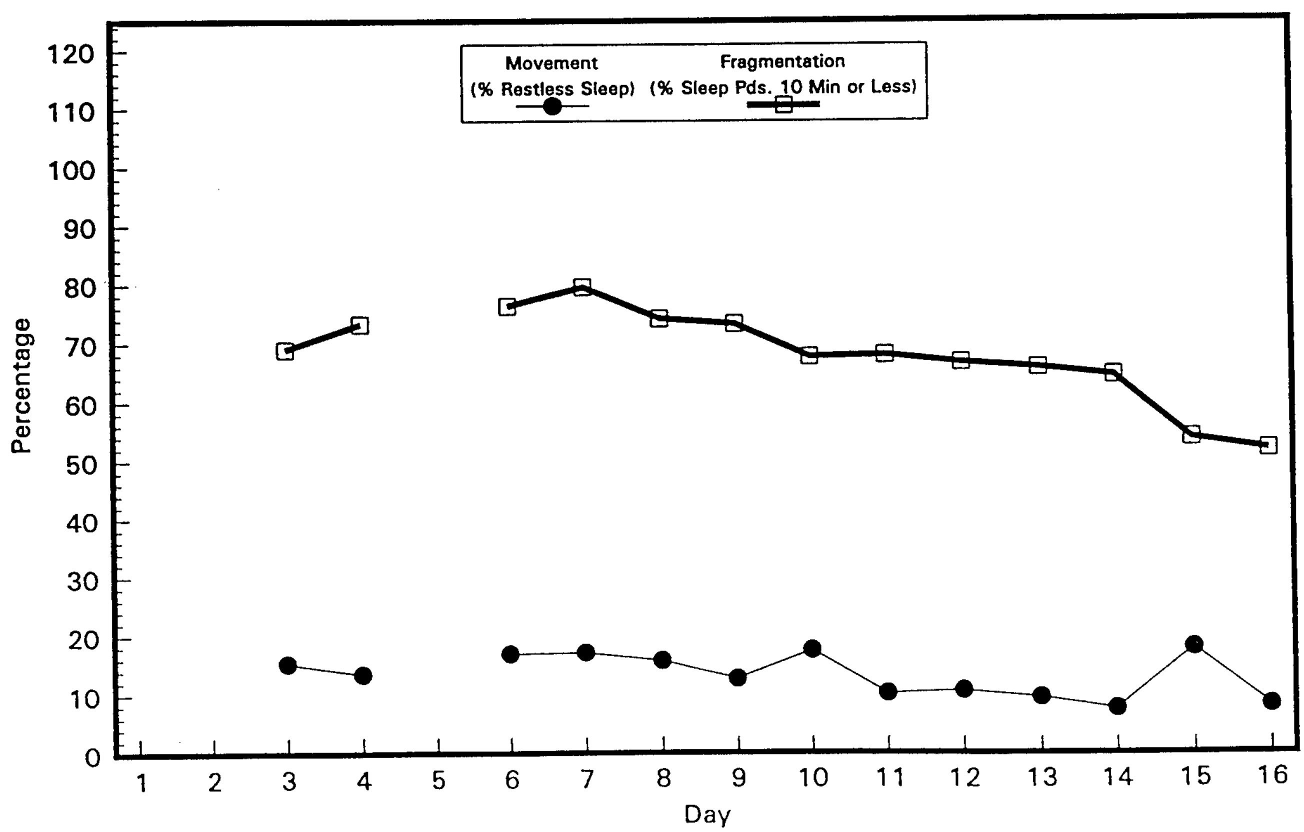

Figure A-14. Quality of Sleep by Day - S3-Plans.

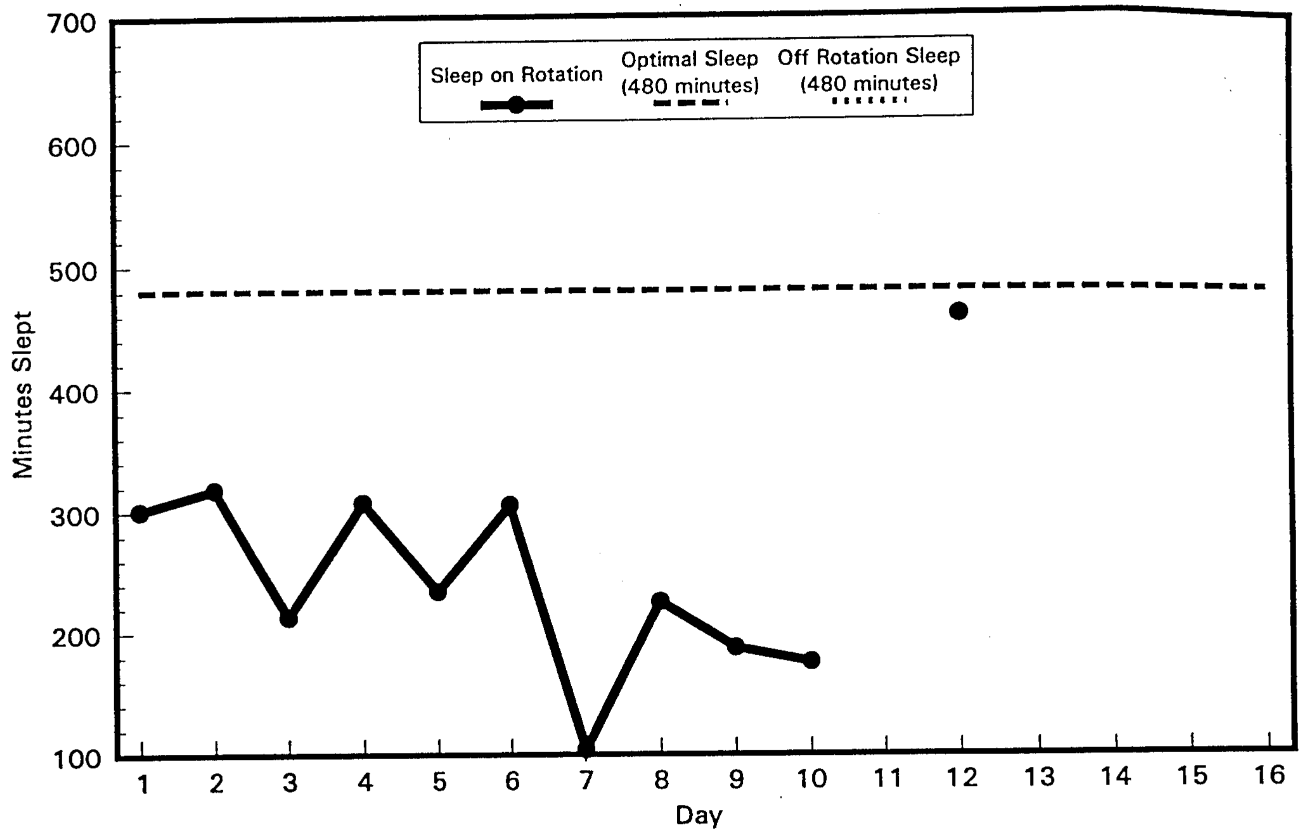

Figure A-15. Comparison of Rotation Sleep vs Individ. Sleep Requirements - S4.

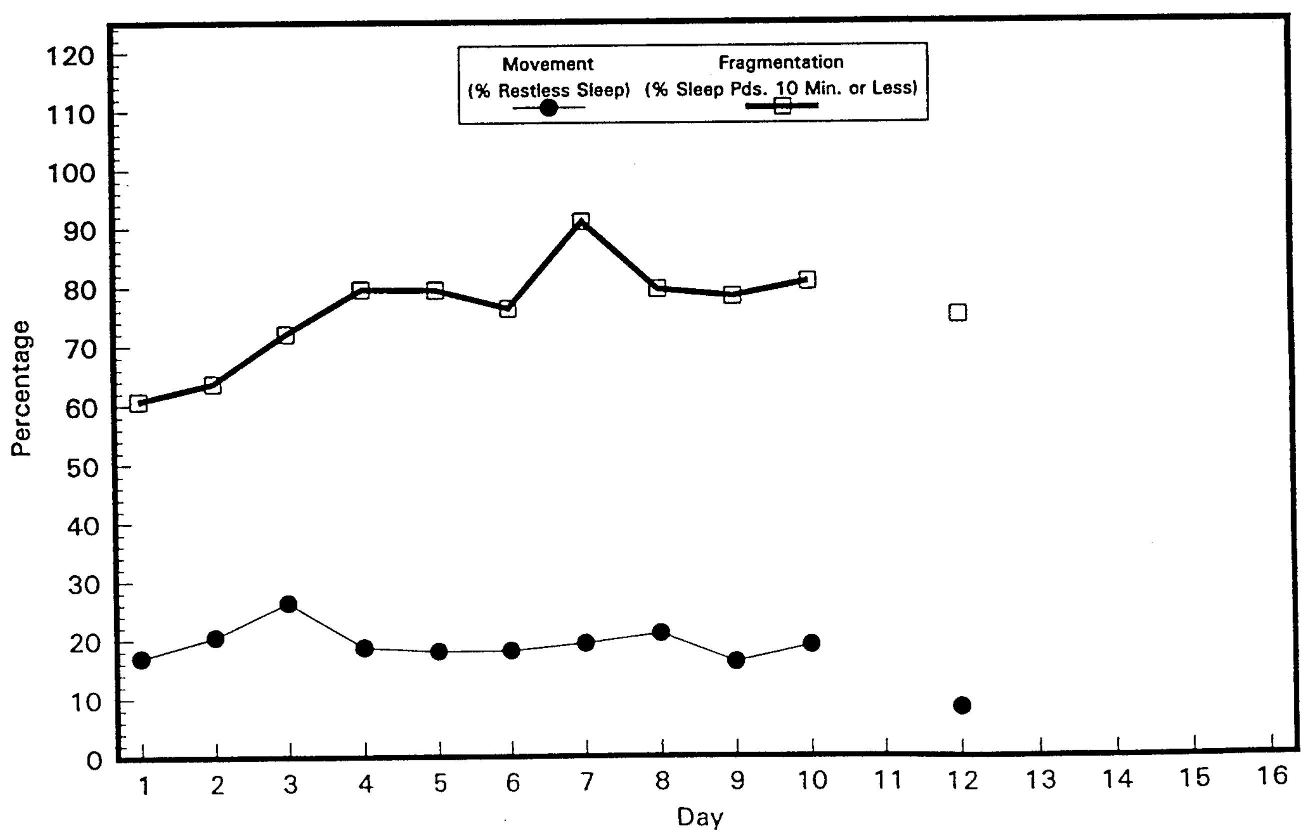

Figure A-16. Quality of Sleep by Day - S4.

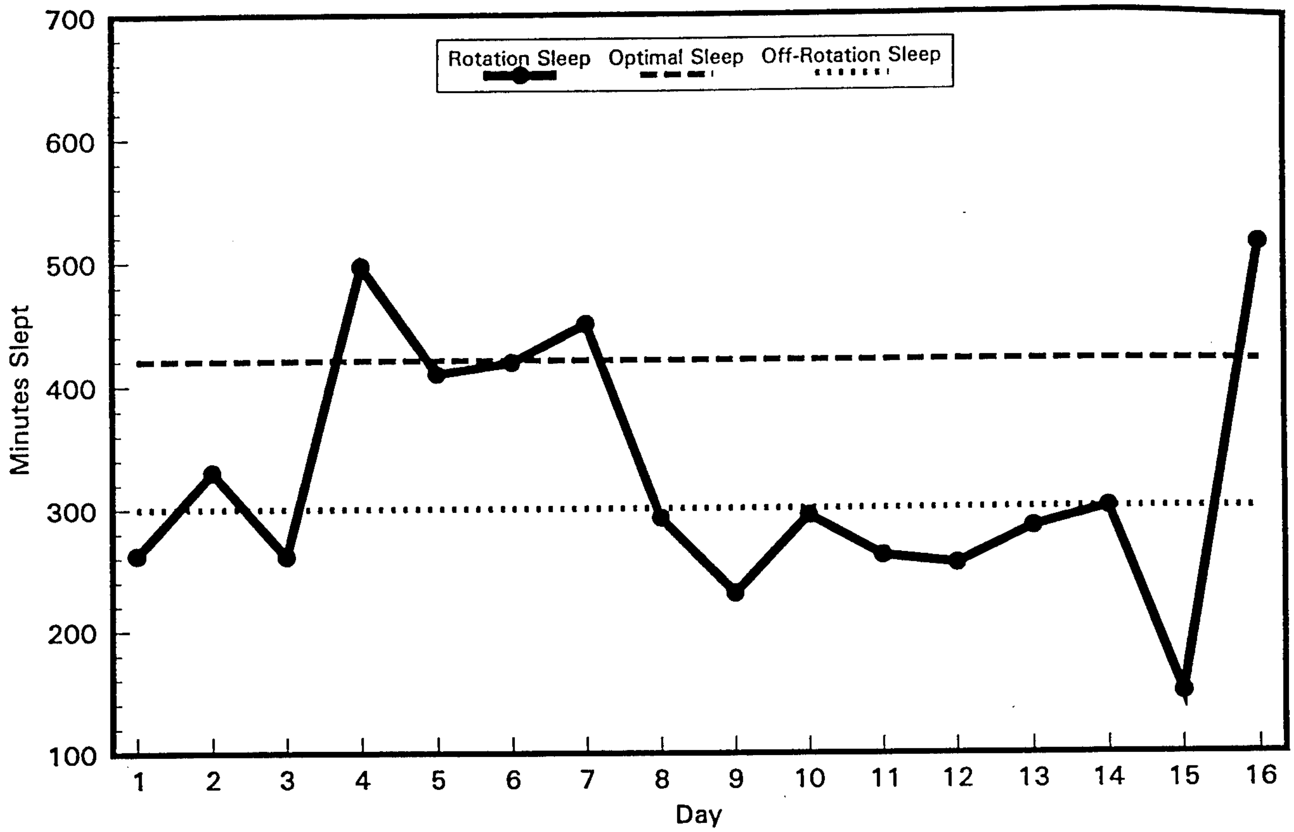

Figure A-17. Comparison of Rotation Sleep vs Individ. Sleep Requirements - S3T.

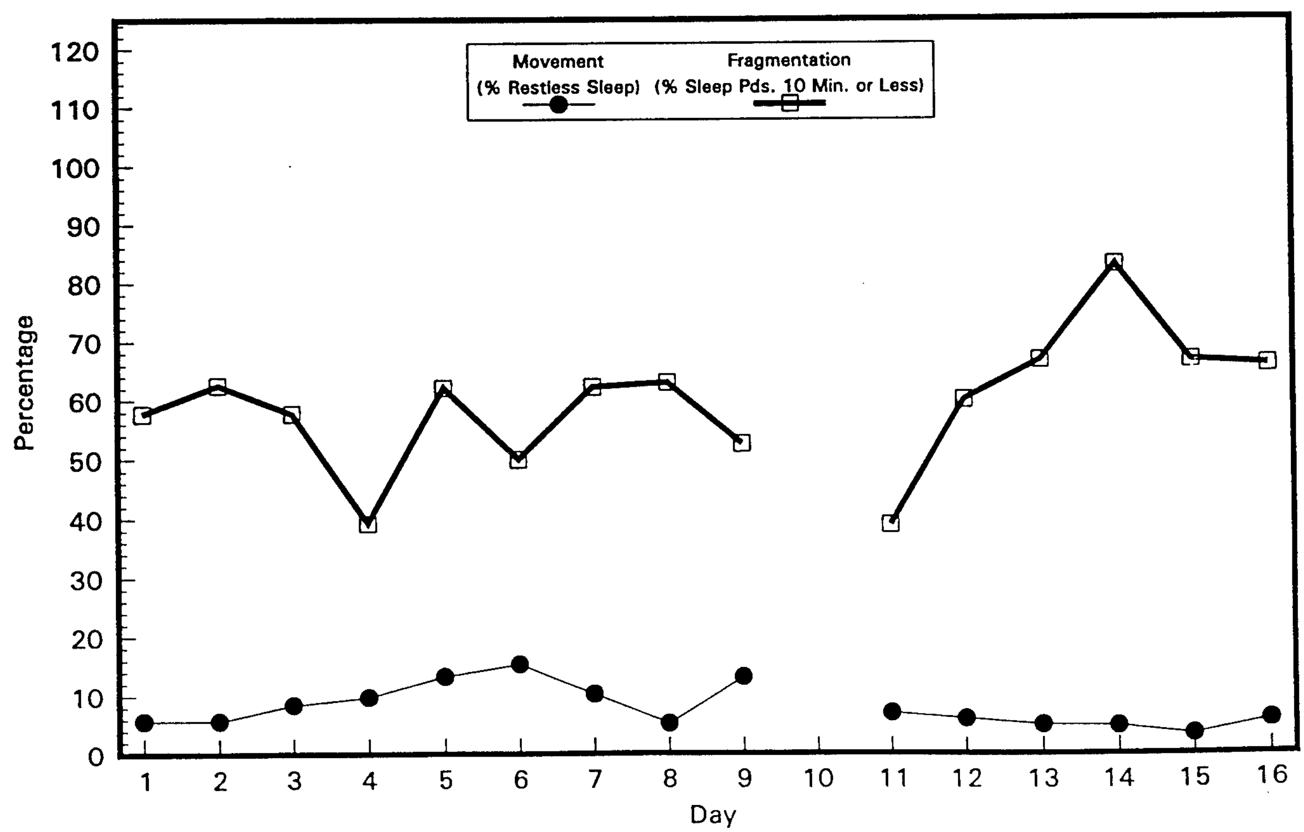

Figure A-18. Quality of Sleep by Day - S3T.

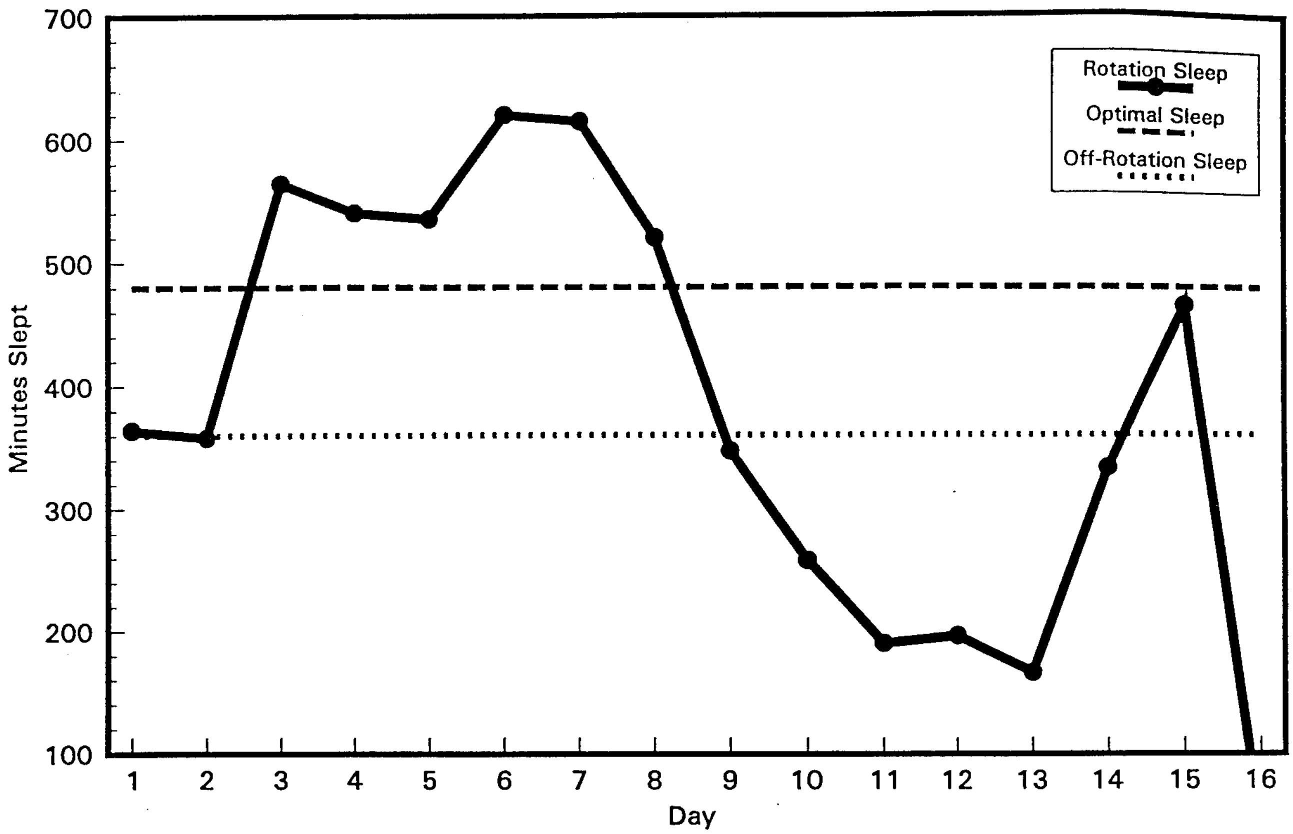

Figure A-19. Comparison of Rotation Sleep vs Individ. Sleep Requirements - ADO.

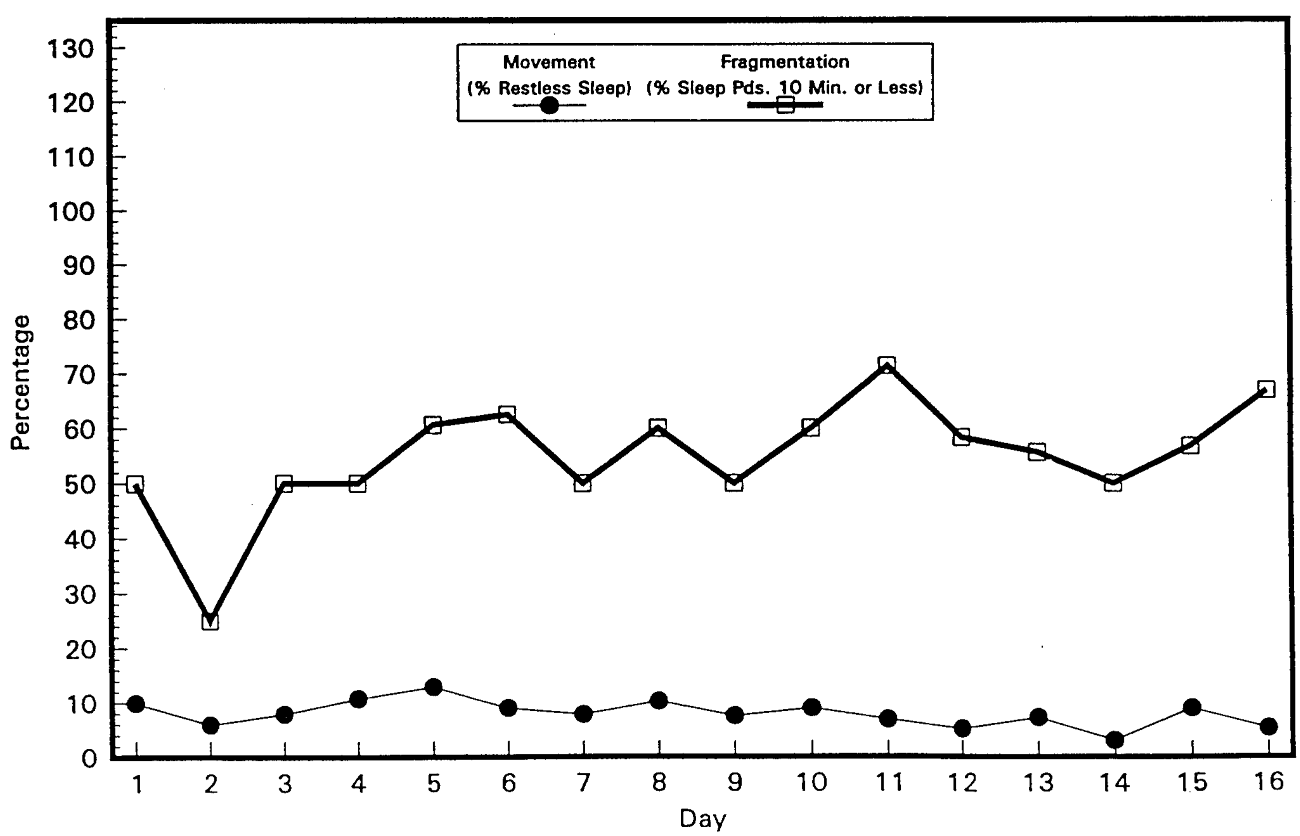

Figure A-20. Quality of Sleep by Day - ADO.

Table B-1

Changes in Mood Ratings Across Phases: S3-Plans

Staff Position: S3-Plans	Insurgency Phase	Attack Phase
Sleepiness	M = 3.0 SD = 2.0	M = 3.0 SD = 2.1
Tense	M = 1.67 SD = .58	M = 1.33 SD = .52
Cheerful	M = 1.67 SD = 1.15	M = 2.17 SD = .75
Relaxed	M = 2.33 SD = .58	M = 2.33 SD = .82
Irritable	M = 2.00 SD = 1.00	M = 1.5 SD = .55
Energetic	M = 1.67 SD = 1.15	M = 2.00 SD = .89
Focused	M = 2.33 SD = .58	M = 2.33 SD = .82
Jittery	M = 1.00 SD = 0.00	M = 1.00 SD = 0.00
Dependable	M = 2.67 SD = .58	M = 2.50 SD = .84
Efficient	M = 2.67 SD = .58	M = 2.5 SD = .84
Sluggish	M = 1.67 SD = .58	M = 1.83 SD = 1.17

Note. Scale values for Sleepiness were as follows:
1 = Feeling active and vital; wide awake.
2 = Functioning at high level, but not at full alertness.
3 = Relaxed, awake, and responsive but not at full alertness.
4 = A little foggy; starting to let down.
5 = Beginning to lose interest in remaining awake; slowing down.
6 = Prefer to be lying down; fighting sleep; woozy.

The remaining mood items used the following scale:
1 = Not at all; 2 = Somewhat; 3 = Definitely; 4 = Extremely

Table B-2

Changes in Mood Ratings Across Phases: XO

Staff Position: XO	Insurgency Phase	Attack Phase
Sleepiness	M = 2.71 SD = 1.25	M = 4.00 SD = 1.83
Tense	M = 1.71 SD = .49	M = 1.75 SD = .50
Cheerful	M = 2.57 SD = .53	M = 3.00 SD = 1.15
Relaxed	M = 2.14 SD = .38	M = 2.50 SD = .58
Irritable	M = 1.00 SD = 0.00	M = 1.00 SD = 0.00
Energetic	M = 2.14 SD = .69	M = 1.75 SD = .96
Focused	M = 2.29 SD = .76	M = 2.50 SD = 1.00
Jittery *	M = 1.00 SD = 0.00	M = 1.75 SD = .50
Dependable	M = 2.57 SD = .53	M = 2.25 SD = .50
Efficient	M = 2.14 SD = .38	M = 2.00 SD = .82
Sluggish	M = 2.00 SD = 0.00	M = 1.75 SD = .96

* p = .002

Table B-3

Changes in Mood Ratings Across Phases: S1

Staff Position: S1	Insurgency Phase	Attack Phase
Sleepiness	M = 1.50 SD = .58	M = 2.00 SD = 1.73
Tense	M = 2.00 SD = 0.00	M = 2.00 SD = 0.00
Cheerful	M = 2.75 SD = .50	M = 2.33 SD = .58
Relaxed	M = 2.50 SD = .58	M = 2.33 SD = .58
Irritable	M = 1.50 SD = .58	M = 2.33 SD = .58
Energetic	M = 2.25 SD = .50	M = 2.67 SD = .58
Focused *	M = 3.00 SD = 0.00	M = 2.67 SD = .58
Jittery	M = 1.25 SD = .50	M = 2.00 SD = 0.00
Dependable	M = 3.00 SD = 0.00	M = 3.00 SD = 0.00
Efficient	M = 2.00 SD = 0.00	M = 2.67 SD = .58
Sluggish	M = 1.75 SD = .50	M = 1.67 SD = 1.15

* p = .05

Table B-4

Changes in Mood Ratings Across Phases: Battalion Staff

Staff Position: Battalion Staff	Insurgency Phase	Attack Phase
Sleepiness	M = 2.39 SD = 1.14	M = 3.04 SD = 1.78
Tense	M = 1.70 SD = .53	M = 1.65 SD = .56
Cheerful	M = 2.55 SD = .71	M = 2.46 SD = .90
Relaxed	M = 2.33 SD = .60	M = 2.46 SD = .65
Irritable	M = 1.36 SD = .60	M = 1.58 SD = .64
Energetic	M = 2.21 SD = .70	M = 2.19 SD = .94
Focused	M = 2.61 SD = .66	M = 2.50 SD = .86
Jittery	M = 1.27 SD = .63	M = 1.54 SD = .71
Dependable	M = 2.88 SD = .42	M = 2.73 SD = .72
Efficient	M = 2.58 SD = .66	M = 2.50 SD = .81
Sluggish	M = 1.73 SD = .45	M = 1.96 SD = .87

OPFOR SLEEP HISTORY QUESTIONNAIRE

GENERAL INFORMATION

SSN (last 4)__________ Duty position_______________ Age_______

OFF-ROTATION SLEEP HABITS

1. **When not on rotation**, how many hours of sleep do you get, on the average, per night?__________

(For questions 2-5 base your answers on the 24 hour clock)

2. What time(s) of the day do you usually feel most alert and awake?

   a) from__________ to__________ and b) from_________ to__________

3. What time do you usually go to bed?__________

4. What time(s) of the day do you feel most tired and sleepy?

   a) from__________ to__________ and b) from__________ to__________

5. What is the best time of day for you to sleep?__________ to __________

6. Could you use more sleep? _____Yes _____No. If yes, how much more?_______

7. Do you feel well-rested after you wake up and first get out of bed?

   _____Always
   _____Most of the time
   _____Often
   _____Sometimes
   _____Very Rarely
   _____Never

8. Do you ever have trouble falling asleep?

   _____Never
   _____Very Rarely
   _____Sometimes
   _____Often
   _____Most of the time
   _____Always

9. If you do have trouble falling asleep, what it is it that keeps you awake?

_____Thoughts running through my mind
_____Aches and pains
_____Too much noise
_____Other_______________________________

10. Do you take anything to help you fall asleep?

_____Never
_____Very rarely
_____Sometimes
_____Often
_____Most of the time
_____Always

11. If you take something to help you fall asleep, what is it?

_____Medicine prescribed by a doctor
_____Over the counter medicine
_____List any other_________________________________

12. Do you take catnaps during the day when you are not on rotation?

_____Never or almost never
_____1 or 2 times per week
_____3 or 4 times per week
_____5 or more times per week
_____More than once a day

13. If you take naps, generally how long are these naps?_______

DURING-ROTATION SLEEP/ACTIVITY HABITS

14. **During a rotation**, how many hours of sleep do you get, on the average, per 24 hours?_______

15. Are your primary sleep periods planned or scheduled for certain times during a rotation?
_____Yes _____No. If yes, when are these sleep periods typically scheduled?

16. Do you feel well-rested after you awake from these sleep periods?

_____Always
_____Most of the time
_____Often
_____Sometimes
_____Very rarely
_____Never

17. In addition to your primary sleep periods, how often, on the average, do you catnap during a rotation?

_____1 or 2 times per week during a rotation
_____3 or 4 times per week during a rotation
_____5 or more times per week during a rotation
_____More than once a day during a rotation

18. If you nap, generally how long are these naps?_______

19. How many cups of coffee do you drink per 24 hours?_______. Other caffeinated drinks, e.g., Coke, Pepsi?_______ cans per 24 hours.

20. How many cigarettes do you smoke per 24 hours?

_____None
_____Less than 1 pack
_____1 pack
_____2 packs
_____More than 2 packs per day

21. Do you use smokeless tobacco? _____Yes _____No

OPFOR WORK LOAD QUESTIONNAIRE

SSN (last 4)__________ Duty position_______________

1. How long have you served in this unit? _____months.

2. How long have served in your current duty position in this unit? _____months.

3. How many rotations have you participated in over the past year with this unit? _______

4. How many days does it take before you begin to feel fully recovered from the effects of a rotation?_______

5. Should there be more recovery time between rotations? _____Yes _____No. If yes, how much time is needed and why?

6. As the rotation progresses, do you change any of your work habits to compensate for increasing fatigue/stress levels? _____Yes _____No. If yes, please describe.

7. Is your current work load excessive? _____Yes _____No. If yes, what can be done to lighten your work load?

8. Does the OPFOR TOC have a formal sleep management plan? _____Yes _____No. If yes, please describe the plan.

9. Is this plan adequate? _____Yes _____No. If no, what modifications are needed?